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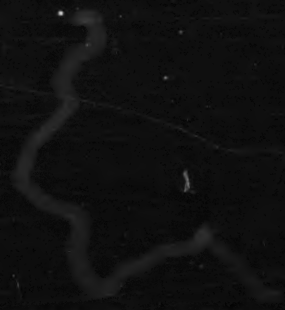
BULLETIN 337

GEOLOGY OF THE PRINCE ALBERT GROUP IN PARTS OF WALKER LAKE AND LAUGHLAND LAKE MAP AREAS, DISTRICT OF KEEWATIN



MIKKEL SCHAU

Canada

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Critical Reader

W.W. Heywood

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Preface

An unusual greenstone assemblage, the Prince Albert Group, was discovered within the gneiss terrane of northern Churchill Structural Province during reconnaissance mapping by the Geological Survey of Canada in the 1960s. Release of the early reports prompted many mining companies to investigate the iron formations, ultramafic rocks and scattered sulphide occurrences of the region. As a result of this interest more detailed studies were initiated by the Geological Survey of Canada.

Results of one of these studies are presented in this report. The late Archean Prince Albert Group is preserved in northeast-trending belts that are characterized by rocks with extreme compositions including quartzites, ultramafic lava flows, dykes and sills, greywackes, and intrusive gabbros and anorthosites.

The presence of komatiites indicates that the nickel potential of the group must be regarded as significant although anomalous trace element values encountered in the Prince Albert Group sediments may be fossil geochemical haloes caused by Archean lateritic weathering of ultramafic rocks.

R.A. Price
Director General
Geological Survey of Canada

OTTAWA, March 1982

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GEOLOGY OF THE PRINCE ALBERT GROUP IN PARTS OF WALKER LAKE AND LAUGHLAND LAKE MAP AREAS, DISTRICT OF KEEWATIN

Abstract

The late Archean Prince Albert Group is the oldest supracrustal unit in the Walker Lake (56J) and Laughland Lake (56K) regions of the Committee Block in the northern Churchill Structural Province. It consists of komatiitic flows, dykes and sills interbedded with quartzites, siltstones, shales and iron-rich sediments derived from the contemporaneous komatiites and underlying basement gneisses of the Brown River Gneiss Complex. Gabbro and anorthosite stocks were emplaced prior to intense deformation.

Structures in the west show complex outcrop patterns, indicating several episodes of folding, whereas in the east the late northeast-trending structures are dominant and only minor folds record a prior history. The group in the western area is composed of uppermost greenschist grade rocks, whereas in the east the rocks are of amphibolite grade, apparently developed at relatively lower load pressures. The Walker Lake Gneiss Complex of latest Archean(?) age formed from the Prince Albert Group and the Brown River Gneiss Complex in the eastern region. Granitic plutons, including garnet-bearing muscovite-rich stocks, were emplaced during and shortly after the gneiss-making event. The Kuagnat Gneiss Complex formed in the northwestern region across a northeast-trending shear zone.

Early Proterozoic mafic dykes were emplaced along northwest-trending faults. Much later, in middle Proterozoic time, small granitic stocks were emplaced along the structural grain and affected nearby units, including the dykes. Regional shearing induced the widespread growth of low grade minerals. Unaltered Mackenzie dykes intrude previously described units.

Résumé

Le groupe de Prince-Albert, qui date de l'Archéen supérieur, est l'unité supracrustale la plus ancienne rencontrée dans les régions de Walker Lake (56J) et de Laughland Lake (56K), qui font partie du bloc de Committee dans le nord de la province structurale de Churchill. Ce groupe consiste en coulées, dykes et sills komaiitiques, interstratifiés avec des quartzites, des siltstones, des schistes argileux et des sédiments ferrifères dérivés de komatiites contemporaines et des gneiss qui constituent le soubassement du complexe gneissique de Brown River. Les amas de gabbro et d'anorthosite ont été mis en place avant un épisode de déformation intense.

A l'ouest, on observe des affleurements complexes qui indiquent plusieurs phases de plissement, tandis qu'à l'est, les structures les plus récentes, orientées suivant une direction nord-est, sont dominantes, et de faibles plissements sont les seuls vestiges des processus antérieurs. Dans la partie ouest du secteur exploré, le groupe est composé de roches métamorphisées au degré le plus élevé du faciès schistes verts, tandis qu'à l'est, les roches métamorphiques se situent dans le faciès amphibolite et se sont apparemment formées à des pressions lithostatiques relativement faibles. Le complexe gneissique de Walker Lake, qui date probablement des dernières phases de l'Archéen, s'est formé aux dépens du groupe de Prince-Albert et du complexe gneissique de Brown River dans la partie est de la région étudiée. Des plutons granitiques, y compris des amas riches en muscovite et contenant des grenats, ont été mis en place pendant et peu après la formation des gneiss. Le complexe gneissique de Kuagnat s'est formé dans la région nord-ouest, à travers une zone de cisaillement d'orientation nord-est.

Des dykes mafiques d'âge protérozoïque inférieur ont été mis en place le long de failles d'orientation nord-ouest. Beaucoup plus tard, vers le milieu du Protérozoïque, de petits amas granitiques se sont installés le long de la tendance structurale du terrain et ont influencé les unités proches, y compris les dykes. Le cisaillement régional a favorisé la croissance sur une grande étendue de minéraux indiquant un métamorphisme faible. Les dykes non altérés de Mackenzie sont intrusifs dans les unités que l'on vient de décrire.

INTRODUCTION

Location

The study area, centred on 92°W and 66°45'N, extends northeasterly and southwesterly to include about 7000 km^2 within Walker Lake and Laughland Lake map sheets.

Present Investigations and Acknowledgments

The Prince Albert Group consists of an unusual greenstone assemblage found in northeast-trending belts within the gneiss terrane of the Committee Bay Block of the northern Churchill Structural Province. The purpose of this study on which this report is based was to determine the structure, stratigraphy and petrology of the volcanic and basic rocks of the Prince Albert Group, to note their relationship to the adjacent gneiss, and to evaluate their mineral potential. Included are the results of field mapping in 1972 and 1973 and subsequent laboratory analysis of several hundred thin sections and about a hundred chemical analyses. The mapping was done by foot traverses from fly camps augmented by helicopter landings in remote areas. The area is near the magnetic north pole, hence magnetic compasses are not reliable. Sun compasses were used in 1973, however, on cloudy days and during most of the 1972 season, magnetic compasses were used, but orientations were checked with airphotos and topographic maps.

The author wishes to thank S.W. Campbell, senior assistant (1973), as well as the junior assistants, W. Barto, G. Dunn, M. Wolff, F. Symons (1972), and G. Campbell, L. deBie, P. Marchand (1973), for their assistance. LaRonge Aviation provided a Cessna 185, piloted and serviced by B. Byl during the 1972 field season, and Viking Helicopters provided Bell 47G4A helicopters, crewed by R. Levack, pilot, and W. Clifford, apprentice mechanic, during the 1973 field season. The author wishes to thank Commander B. Lapointe

and his crew of the Canadian Armed Forces for their assistance following a helicopter crash in 1973. Provisions were supplied by the Hudson's Bay Company in Baker Lake, 1972, and the Naujak in Repulse Bay, 1973.

The staff of the laboratory services of the Geological Survey are especially to be thanked for their sample and thin section preparation, and mineralogical and elemental analyses. M. Henderson, W. Houston and P. Chernis also provided valuable help. The author's colleagues, especially Drs. F.H.A. Campbell, T.M. Gordon, J.B. Henderson and W.W. Heywood, critically reviewed some of the ideas presented here.

History and Previous Geological Investigations

The area is sparsely populated. In the early part of the century, trappers and hunters from Gjoa Haven visited the area (Boas, 1884-85; Freeman, 1976). Coastal Inuit camped at Wager Bay until the early 1960s and hunted and fished inland in the southern parts of the region. Lieutenant F. Schwatka traversed the region in 1868, meeting a nomadic Inuit group from the west, near Hayes River, within the mapped region. A campsite on an esker in a wide part of the Hayes River near this meeting place may be Stewart's monument noted by Schwatka in his narrative (Stackpole, 1965). It was used by the Geological Survey when the region was first systematically mapped geologically (Heywood, 1961) and has remained the principal campsite of investigators in the region. The release of Heywood's report prompted many mining companies to explore the ultramafic deposits of the region (LaPorte, 1974a,b).

Accessibility

Baker Lake and Repulse Bay, the only nearby settlements, are serviced by commercial flights from Churchill, Manitoba. Charter aircraft are often available at Baker Lake, Rankin Inlet, or Churchill. Within the map area, glacial debris (boulder fields) and irregular drainage, characterized by shallow lakes and rapid-studded rivers, make foot and boat travel laborious. Rivers break up between late June and mid-July and may be clogged with ice until early August. Their water levels fall rapidly throughout the short summer season. Larger lakes do not break up every summer.

Vegetation and Game

The area is north of the treeline and its flora displays a brief but colourful parade of many small arctic flowers. Larsen (1971) provided details of important species in the general area.

Wildlife is not abundant. A muskox was seen on the Brown River; caribou, singly and in small groups, were a common sight. Wolves, arctic foxes and hares were rarely seen. Richardson ground squirrels were common. Several peregrine falcon pairs nest in the area immediately north of the Arctic Circle on the Hayes River, and ptarmigan were common throughout the upland region. Lake trout and arctic char could be caught in many lakes. Mosquitoes are locally abundant, but no biting flies were encountered.

Climate

The map area lies within the zone of continuous permafrost and the mean annual temperature is about -20°C. Temperatures during July range from a mean low of +5°C to a mean high of +12°C.

Most of the snow falls in late autumn and early spring and the mean snow cover for April is near 50 cm (Fremlin, 1974). Blizzards are rare during July or August. A small amount of ice remained in depressions and ice-rich colluvium at the base of slopes in a hummocky region on the north shore of the Hayes River, 3 km east of where it crosses 92°W, throughout the summers of 1972 and 1973.

Topography and Drainage

The region, part of the Wager Plateau (Bostock, 1970), has been considerably modified by continental glaciation (Craig, 1961, 1965a, 1965b; Thomas, 1977). The relief and average elevation is about 300 m. Glacially sculptured hills of ultramafic rocks, quartzite, and granitoid rocks stand above boulder fields and till and sand plains. Details of ice movement are recorded by north-northwesterly directed drumlins, striations, and anorthosite boulder trains.

The map area is drained to the northwest by Hayes River, to the northeast by Kellett River, and to the southeast by Brown River.

GEOLOGY OF PART OF LAUGHLAND LAKE AND WALKER LAKE REGIONS

Introduction

General Statement

The region studied (parts of NTS 56J and 56K) constitutes a portion of the Committee Fold Belt (Jackson and Taylor, 1972) within the northern part of the Churchill Structural Province (Stockwell, 1964). It is part of a newly defined structural subdivision, the Committee Bay Block (Heywood and Schau, 1978) whose components include middle(?) Archean to early Phanerozoic rocks. This paper discusses some of the rock types formed in the earlier part of this time span.

Previous Work

Heywood (1961) first mapped the region by helicopter during Operation Back River. He divided the rocks into old volcanic and sedimentary rocks altered to, and intruded by, gneisses and plutons, and subsequently cut by dykes. He noted the presence of quartzites and ultrabasic lenses in the oldest unit which he later correlated with the Prince Albert Group (Heywood, 1967). A disagreement arose as to the age of the Prince Albert Group. An Aphebian age was favoured by Jackson and Taylor (1972) and an Archean age by Davidson (1972). Preliminary reports by Campbell (1973, 1974), Frisch (1973, 1974), Schau (1973, 1974) and Schau and S.W. Campbell (1974) have favoured the Archean age.

The quartzite, ultramafic flow, dyke, and sill association common in the mapped area (Schau, 1975b, 1977) grades into metamorphosed quartzose greywackes to the east, and on Melville Peninsula a volcanic component increases to form the bulk of the rocks (Schau and F.H.A. Campbell, 1974; Campbell and Schau, 1974; Schau, 1975a, 1977; Frisch and Goulet, 1975; Frisch and Jenner, 1975). The quartzite-ultramafic flow, dyke, and sill association has been actively investigated for mineral deposits (LaPorte, 1974a,b; Eckstrand, 1975b). The metamorphism of the Prince Albert Group in District of Keewatin has been summarized (Schau, 1978).

Gneiss underlies about two thirds of the northeastern part of the District of Keewatin (Eade and Fahrig, 1971). An attempt was made in this map area to divide the gneiss terrane into several gneiss complexes on the basis of relationships with the Prince Albert Group. A variety of laboratory techniques have also been used to separate the older and younger gneisses (Schau, 1974, 1975c; Schau and S.W. Campbell, 1974).

Subsequent to the completion of geological field work, aeromagnetic maps, airborne gamma-ray spectroscopy maps and surficial maps became available and have assisted in the interpretation of the geology.

Geographical Nomenclature

As the area has few named topographical features it is difficult to describe geographic locations. Therefore the area is divided into three geographic regions and specific points are identified by letters or numbers on Figure 1.

Summary of Geology

The Committee Bay Block shows the structural and metamorphic features characteristic of a high to intermediate level crustal block (Heywood and Schau, 1978, Fig. 2, in pocket, Table of Formations).

Supracrustal Prince Albert Group rocks were deposited on the Brown River Gneiss Complex and both were intruded by gabbros and anorthosites. This was followed by deformation, formation of the Walker Lake Gneiss Complex, and intrusion of granites at shallow to moderate depth. Movement along the Kellett Fault brought the Kuagnat Gneiss Complex against the deformed Prince Albert Group and associated gneiss complexes. Later north-trending basic dykes, and even later local granitic plutons, were affected by regional crushing and shearing. The Mackenzie dykes are the youngest rocks in the region.

Brown River Gneiss Complex

Name and Distribution

Gneisses interpreted to be basement to the Prince Albert Group occur near the headwaters of the Brown River and are named for this geographical feature. The distribution of this complex is not well known, but, in a few places it is demonstrably older than the Prince Albert Group. Gneisses which are physically continuous with this older gneiss and other gneisses which are similar to them in mesoscopic structures and mineralogy constitute this complex. Most of the gneisses southwest of Hayes River and southeast of the Kellett Fault (Heywood and Schau, 1978) are considered part of this complex. Other gneiss complexes to the north (Kuagnat Gneiss Complex) and northeast (Walker Lake Gneiss Complex) probably contain a large component of Brown River Gneiss Complex, but they also contain younger materials and hence are not grouped with the Brown River Gneiss Complex.

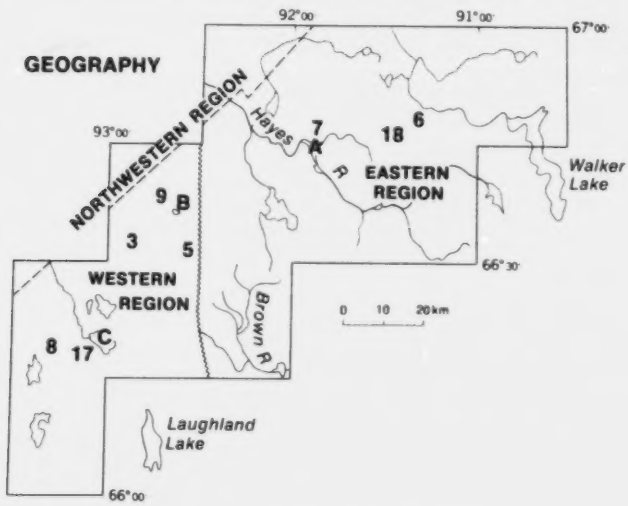


Figure 1. *Index map of Walker Lake-Laughland Lake map area. A, B and C, are geographic reference points. Numbers indicate localities of figures.*

Lithology

The Brown River Gneiss Complex contains gneisses that are well layered and others that are irregularly, weakly or sparsely layered. Both types are well foliated.

Well layered gneisses occur mainly north of, and at the head of, Brown River, and extend easterly to Hayes River. Light coloured layers of quartzofeldspathic gneisses speckled with epidote contain biotite-rich layers or aggregates 1 to 10 cm thick. Scattered, darker layers are thicker and are also biotite-rich, with biotite lamellae containing varying amounts of hornblende, garnet, and/or epidote. A calcareous "concretion" was noted associated with a biotite- and epidote-rich layer. The quartzofeldspathic layers locally contain as much as 40 per cent quartz. Poikiloblastic plagioclase porphyroblasts are prominent in some leucocratic layers. The gneisses, ususally grey, are locally stained to reds or pinks by degradation products of rare but ubiquitous pyrite. Epidote-speckled granite or aplite dykes and concordant veins intrude the gneisses.

The quartzofeldspathic layers of the gneisses contain quartz, microcline, and several generations of plagioclase, one of which may be poikiloblastic and porphyroblastic. The biotite is pleochroic in browns and the chlorite developed from it has purple to black birefringence. The accessories are zircon, apatite and allanite. Sphene or leucoxene and very small grains of pumpellyite are mixed with the saussuritized feldspars. The biotite-bearing darker layers of the layered gneisses contain old and new plagioclase crystals, microcline, medium grained granoblastic quartz specked with muscovite or white mica and epidote or clinozoisite. Green pleochroic biotite, and grey birefringent optically postive chlorite, associated with accessory minerals such as zircon, apatite and possibly, allanite, constitute 20 to 25 per cent of such a layer. Aplite within the layered gneisses contains quartz, relict and neomorphic poikiloblastic plagioclase, graphic granite intergrowths, locally developed clay alteration, epidote, and sericite. The rare biotite is pleochroic in greens and the chlorite has purple to black birefringence. The opaques are altered to leucoxene.

The layered gneiss is generally tonalitic in bulk composition, although the lighter layers are granodioritic to granitic (Table 2, no. 1-7).

From Brown Lake to the headwaters of Brown River the area is underlain by a foliated, locally leucocratic rock containing small variously oriented inclusions of layered gneiss consisting of biotite and/or hornblende layers. The rocks are sheared to schistose or foliated, equigranular to locally porphyroblastic or porphyritic, fine- to medium-grained biotite-granodiorite* to hornblende-biotite tonalite.

The outlier on the northern tributary of the Hayes River contains local layers of foliated granitoid rocks in layered gneisses in the core of an anticline. At one place (Schau, 1975c) a foliated leucocratic granitoid rock with a slightly greenish tinge is composed of vaguely oriented plagioclase, potash feldspar, and quartz, in roughly equal proportions. The plagioclase is of two types: one is medium- to coarse-grained and saussuritized with clay, epidote and white mica, the other is fine grained, polygonized, and untwinned to rarely twinned albite. Potash feldspar may be either orthoclase or microcline. Coarse grained quartz with strained lamellae or polygonized aggregates surrounding the coarser grains constitutes about 30 per cent of the rock.

*The I.U.G.S. model classification is used throughout (Streickeisen, 1976).

TABLE OF FORMATIONS

		Units	Lithology
PHANEROZOIC		HOLOCENE	glacial deposits
		profound unconformity	
PROTEROZOIC	"late"	MACKENZIE DYKES	diabase
		intrusive contact	
	"middle"	Late Granite Stocks	red weathering granitic stocks
		intrusive contact	
	"early"	Metadiabase dykes	metadiabase
		intrusive contact	
ARCHEAN	"late"	Granitic Plutons	foliated and massive plutons, including muscovite-bearing granites
		intrusive or gradational contact	
		WALKER LAKE GNEISS COMPLEX	granitoid and layered gneisses derived from Prince Albert Group and Brown River Gneiss Complex
		intrusive, gradational and/or faulted contact	
		KUAGNAT GNEISS COMPLEX	granitoid and layered gneisses
		faulted contact	
		LAUGHLAND LAKE ANORTHOSITES	meta-anorthosite
		intrusive contacts	
		PRINCE ALBERT GROUP	metamorphosed supracrustal rocks with komatiites, quartzites, pelites and iron-rich rocks
		fault and/or probable unconformity	
	"middle(?)"	BROWN RIVER GNEISS COMPLEX	granitoid and layered gneisses

Small amounts of anhedral microcline, partly to entirely chloritized biotite, epidote and muscovite blebs, apatite and opaques, constitute 10 per cent of the rock. The rock is classified as granite or granodiorite. This is confirmed by the chemical analyses (Table 2, no. 8-11).

Structures

Internal Relations

Two lithologies have been differentiated on the presence or absence of well developed layering, but the contact between the two has not been seen.

Near and southwest of the intersection of 92°W and the Arctic Circle the orientations of the layers give the impresssion of a generally tightly folded, steeply dipping, easterly to northeasterly trending succession with minor fold axes that plunge steeply to the west or southwest.

The foliation in the weakly layered rocks also parallels that in the Prince Albert Group. The foliation near the Brown River trends north-northeast and dips steeply. Near the Prince Albert Group quartzite outlier on the Hayes River the steeply dipping foliation can be traced for several kilometres northeast along strike with no obvious variation in composition along the foliation trend, whereas only a few kilometres to the north layered gneisses show considerable variation in orientation and composition on a single outcrop.

There are inclusions of layered gneisses and mafic schlieren in the foliated granitoid rocks north of the Laughland anorthosite outlier.

External Relations

The Brown River Gneiss Complex is in fault contact with, and apparently underlies the Prince Albert Group. It is intruded by gabbro and anorthosite stocks, granitoid plutons, metagabbro dykes and a Mackenzie dyke, and it grades into a younger gneiss complex.

The unconformable relationship of the Brown River Complex and the Prince Albert Group is shown by structural and metamorphic discordances at the contact and by the presence of gneissic detritus in basal sediments of the Prince Albert Group. The apparent angular discordance between the layered gneisses and the nearby layers in the Prince Albert Group is as much as 30° south-southwest of A (Fig. 2), whereas the foliation in the granitoid rocks of the complex appears to parallel that in the Prince Albert Group. West-southwest of A and east-northeast of B a block of gneiss is tightly folded with a schistose metakomatiitic sill of the Prince Albert Group (Fig. 3). The gneisses, metamorphosed to amphibolite grade, are partly degraded to greenschist. The maximum grade that the Prince Albert Group attained in the southwestern part of the mapped area was greenschist. South of A (Fig. 1) small granules and pebbles of foliated granitoid rock are present in the sediments of the Prince Albert Group near their contact with this gneiss complex. Relatively undeformed ultramafic dykes cut the complex (66°40'N, 92°09'W).

A possible unconformity occurs (66°24.6'N, 92°28.8'W) where vertically foliated tonalite grades over 10 m into well layered, vertically dipping, conformable metasedimentary rock. There flattened discs (pebbles or cobbles?) or quartzo-feldspathic material occur in a biotite-rich matrix. One hundred metres to the east, across a valley, rare crossbeds and ripple marks in a metagreywacke sequence indicate that the foliated tonalite is stratigraphically below the metasediment.

North-striking normal faults with west side down bring the younger Prince Albert Group in contact with the Brown River Gneiss Complex along 91°31'W and 93°07'W. Foliation in the gneisses is near the fault subparallel to its trace.

Metamorphism and Mode of Origin

The Brown River Gneiss Complex consists of high grade metamorphic layered rocks which were veined by aplites or intruded by granitoid plutons. All components of the complex were subsequently deformed and locally degraded to greenschist grade. Garnet- and hornblende-bearing layered gneisses are indicative of amphibolitic metamorphic grade. That the gneissic terrane within which granitoid plutons were emplaced was near its melting point is suggested by the local graphic granite textures (as seen in thin section), the widespread occurrence of aplite veins and dykes, and the occurrence of inclusions or schlieren of layered gneisses within the granitoid plutons. The degradation to greenschist grade is shown by widespread occurrence of epidote and chlorite, chlorite and potash feldspar, local saussuritization of feldspars, and carbonation along shear or joint surfaces.

Age and Correlation

The layered gneisses and enclosed plutons are older than the Prince Albert Group. They were deformed and remetamorphosed with the Prince Albert Group. No radiometric data have been obtained for these rocks. The nearest gneiss of possible comparable age and origin is basement gneiss in the Amer Lake area (65°45'N, 97°W) (Tella and Heywood, 1978; Heywood, personal communication, 1979).

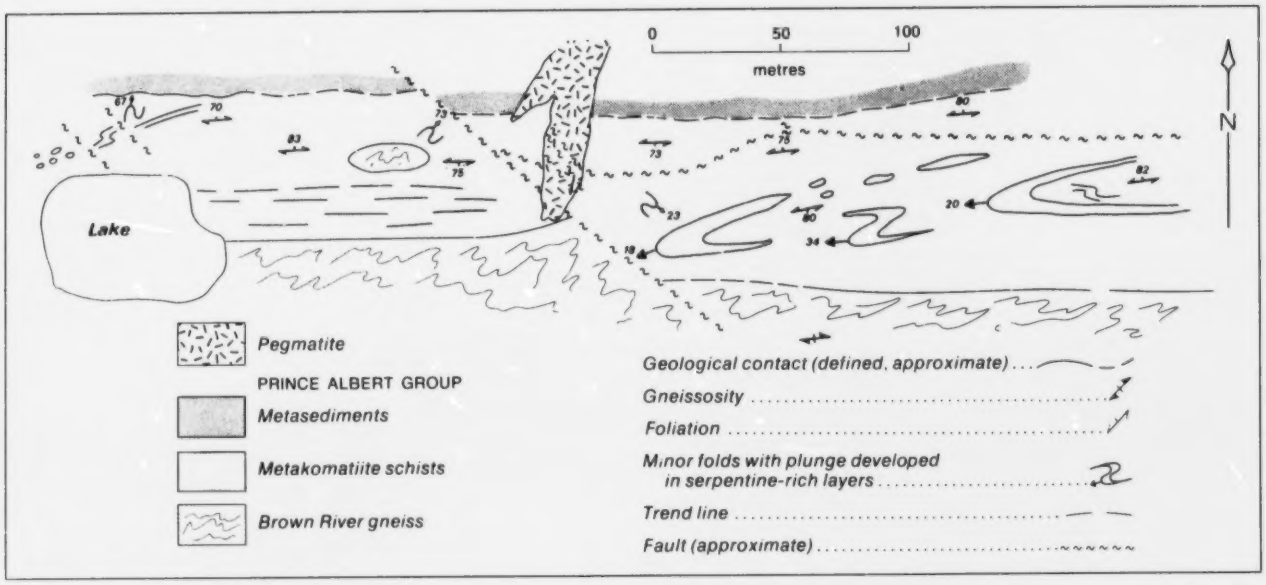
Prince Albert Group

Introduction, Name and Distribution

The term Prince Albert Group was introduced by Heywood (1967) to "...refer to a sequence of Aphebian or Archean metamorphosed sedimentary and volcanic rocks. On Melville Peninsula these rocks are exposed in two main belts although small bodies of similar rocks in the same general area are probably related. The western belt extends for 40 miles and consists of four irregularly shaped bodies. These are parts of a once continuous unit that is now separated by faulting and granitic intrusion. The eastern belt extends for about 50 miles southeast from the coast at Parry Bay in the northeast corner of the map-area, and is as much as 8 miles wide and averages about 4 miles. Faults and granitic intrusions disrupt its northern half. A narrow belt of metamorphosed sedimentary rocks with minor amounts of volcanic rocks extends southwesterly from Committee Bay, south of Cape Weynton to the western boundary of the area. This belt ranges from less than one mile to about 5 miles in width. The contacts with the adjacent gneisses are sinuous in detail and in places are gradational over a few tens of feet.

"The sequence of rocks exposed on Melville Peninsula differs slightly from that exposed southwest of Committee Bay. Metavolcanic rocks are abundant in the former area but rare in the latter, whereas quartzite is a prominent member in the Committee Bay area, but not common on Melville Peninsula. Iron-formation occurs in both areas but is best developed on Melville Peninsula...".

The Prince Albert Group as defined is exposed from the northern tip of Melville Peninsula (NTS 47D) to west of Laughland Lake (NTS 56K) (Heywood, 1961, 1967, 1974) (Fig. 4). This group apparently covered a large portion of the Committee Bay Block and a large part of Baffin Island as well if the correlation of the Mary River Group and the Prince Albert Group of Jackson and Taylor (1972), is used. In the Laughland Lake and Walker Lake areas the Prince Albert Group forms southwest-trending belts that diverge southward around a central north-south elongate, fault-bounded area of Brown River gneiss. The Prince Albert Group has not been recognized northwest of the Kellett River Fault (Heywood and Schau, 1978). Rocks of the Prince Albert Group have been mapped near the head of Wager Bay trending towards Curtis Lake (Heywood, 1961).



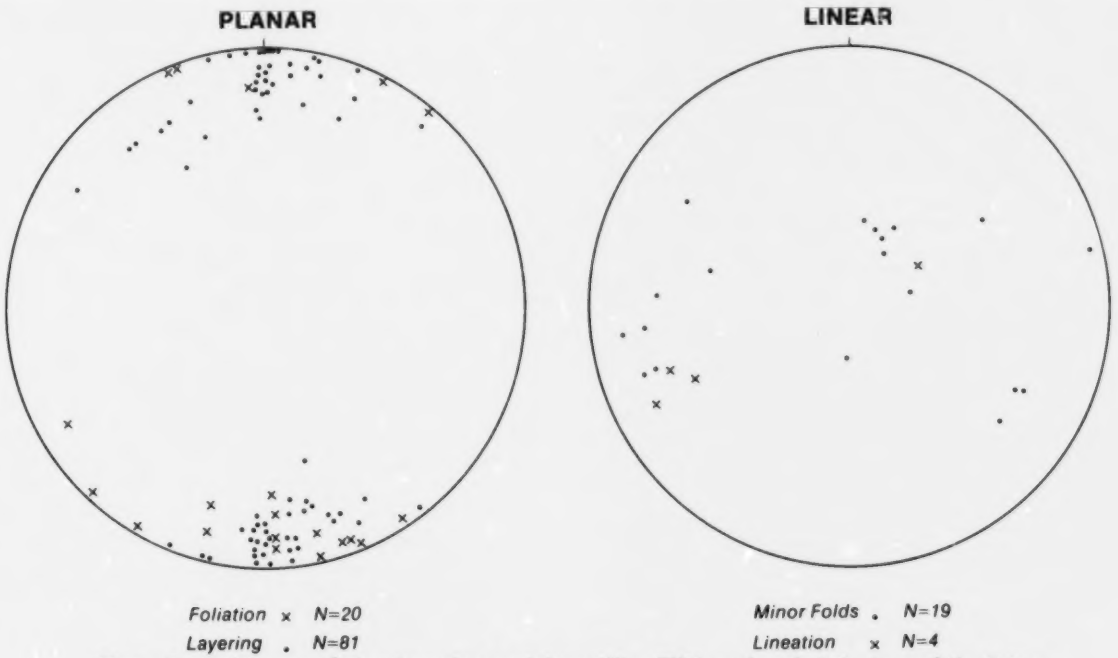


***Figure 3**. Sketch map of structures in a metakomatiite sill(?) emplaced at the base of the Prince Albert Group. The gneiss xenolith or tectonic inclusion indicates that it is older than the enclosing metakomatiite. Mapping by P. Marchand, 1973.*

Lithology

The Prince Albert Group consists of a metamorphosed suite of supracrustal rocks. About one third are chlorite or actinolite schists and one third are phyllite, biotite schists, or "gneissic" mica-rich rocks. Approximately equal amounts of oxide iron formations, very pure quartzite and massive greenstone with finely layered amphibolites and rare limy units, constitute the remainder. Attempts to subdivide metavolcanic or metasedimentary rocks have been hampered by the scarcity of original structures. Metavolcanic rocks are locally spinifex-bearing or brecciated, locally well layered, chlorite-rich units (peridotitic komatiites). Metasedimentary rocks are locally well layered and contain crossbedding, ripple marks and graded beds as well as locally identifiable clasts but many schists contain no trace of primary textures.

Metavolcanic Rocks

Thin lenses and layers of ultramafic schists are common within the outcrop region of the Prince Albert Group in the eastern region. A large area (about 25 km by 7 km) of

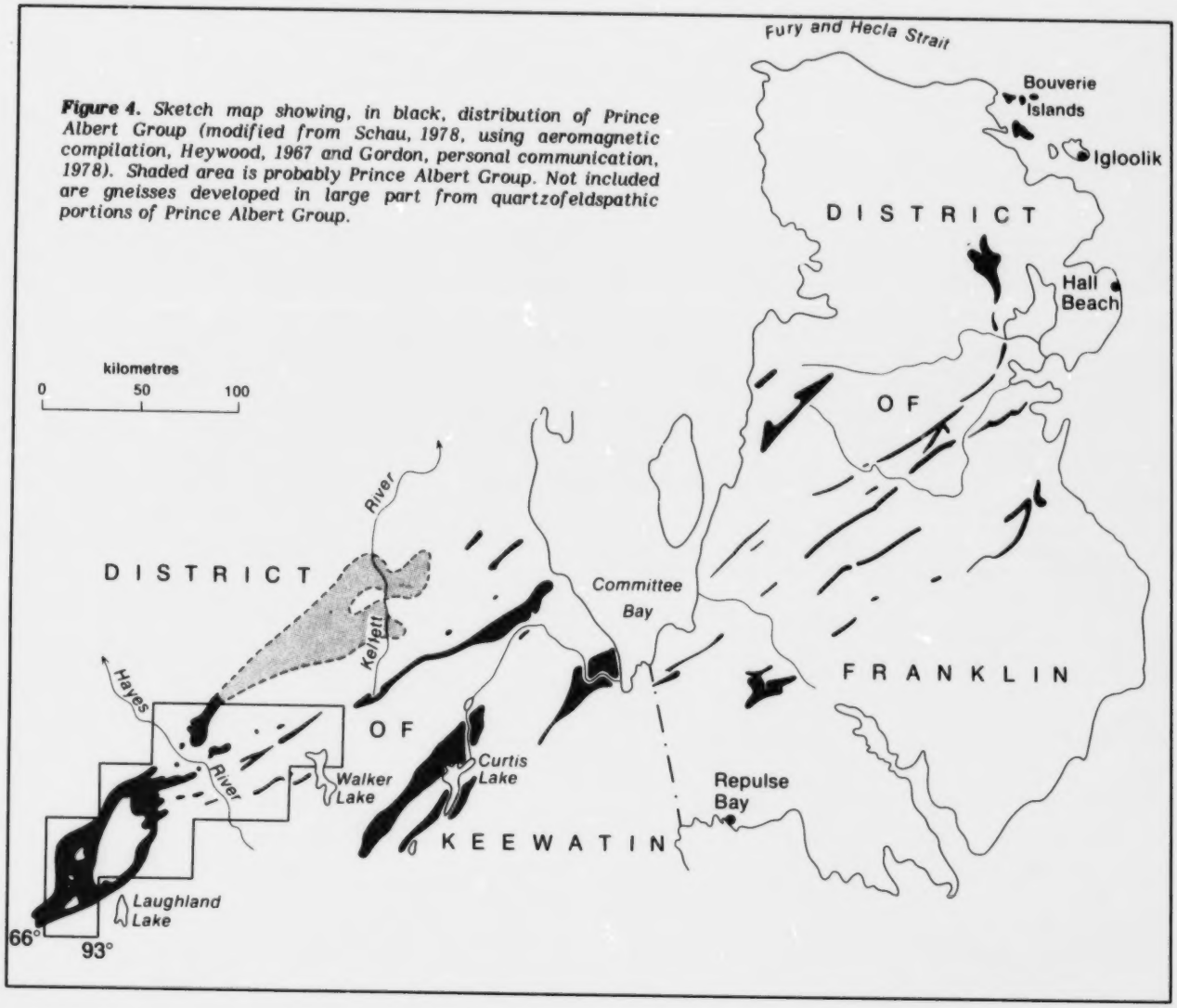


Figure 4. *Sketch map showing, in black, distribution of Prince Albert Group (modified from Schau, 1978, using aeromagnetic compilation, Heywood, 1967 and Gordon, personal communication, 1978). Shaded area is probably Prince Albert Group. Not included are gneisses developed in large part from quartzofeldspathic portions of Prince Albert Group.*

chloritic and serpentinitic schists outcrops along the north-south fault. Lenticles of ultramafic schists found north of Laughland Lake occur as glacially shaped hummocks protruding from the boulder fields. Chocolate brown weathering layers, 0.5 to 2 m thick, consist of tremolite and chlorite and/or serpentine locally spotted with olivine, interleaved with pale green weathering actinolite schists.

The ultramafic rocks, are generally tectonites consisting of chlorite, tremolite and lesser amounts of antigorite-serpentine, talc, anthophyllite, olivine, carbonate, magnetite, and pyrite. In a number of areas, especially near Hayes River and at the head of Brown River, spinifex textures are present (Eckstrand, 1975b; Schau, 1975b, 1977). Eckstrand (1975b) described ultramafic flow units 1 to 2 m thick containing well preserved spinifex textures; the spinifex layers weather dull grey-green and the originally more olivine-rich cumulate layer, a brighter reddish brown. Tremolite, chlorite, antigorite and magnetite pseudomorph the spinifex textures (Fig. 5; Schau, 1977). The subparallel blades of long olivine crystals have been replaced by small randomly oriented tremolite grains, separated by a rim of fine magnetite grains. The matrix is composed of very fine grained, length-fast, nearly isotropic, anomalously brown birefringent chlorite. These pseudomorphic textures are distinguished from metamorphic textures in which thick plates of similar chlorite grow at 60° angles to each other. Tremolite-chlorite forms the matrix in the latter. Eckstrand (in Schau, 1977) described the presence of undeformed tremolite crystals apparently pseudomorphs of olivine crystals which had grown across sheared and folded layering in the ultramafic units in the Hayes River area. Olivine veins and anastomosing olivine crystals can be seen in thin sections of rocks from the eastern part of the map area. Tremolite crystals in a biotite chlorite matrix (Schau, 1975b) may be pseudomorphs of olivine but the relationship could not be confirmed from an examination of thin sections. Both pseudomorphic spinifex textures and similar metamorphic textures may occur in the same units. Near many fold cores polyhedral cracks in ultramafic rocks resemble those in Munro Township (Arndt et al., 1977). These crackling features are difficult to distinguish from tectonic breccias in the Hayes River area. Thin lenses of massive greenstones are composed mainly of tremolite and chlorite grading into the chlorite and actinolite schists. A biotite-bearing, khaki-coloured schist unit occurs intimately interlayered with the

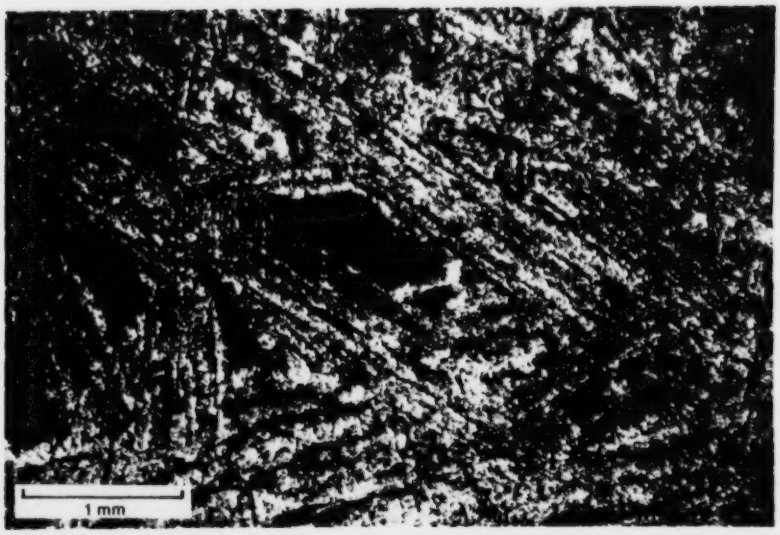


Figure 5

Photomicrograph of spinifex textures in metakomatiite (after Schau, 1978). GSC 202873-A

layered ultramafic rocks at the contact between the ultramafic rocks and metasedimentary rocks, and as transverse schist zones in the layered ultramafic rocks. Structures in it include peculiar breccias with rounded pillow-like fragments.

Metasedimentary Rocks

Metasedimentary rocks associated with the metakomatiites include: two-mica schists, phyllites, chlorite schists, actinolite schists, amphibolites, magnetite amphibolites, iron formations, feldspathic arenites, quartzose muscovite schists, quartzites, quartzites with aluminosilicates, and carbonates. Iron-rich units are near and associated with ultramafic rocks and carbonates. Pelites and quartzites are interlayered with the ultramafic rocks. There is a difference in the fabric of the rocks found in the eastern and western regions of the map area. In the west, phyllites, fine grained schists, cataclastic quartzites, and carbonated volcanic ultramafics are present, whereas in the east, schists are commonly coarsely porphyroblastic, quartzites are annealed, and ultramafic rocks contain porphyroblastic olivine.

Coarse clastic rocks occur near the base of Prince Albert Group in several places near the headwaters of Brown River and south of point A (Fig. 1). The clasts, ranging from discoid cobbles to granules of feldspar and quartz, are set in a biotite-rich matrix and in one place, a carbonate matrix. Thin beds of flattened conglomerate contain closely crowded clasts of amphibolite resembling the ultramafic rock south of lake B (Fig. 1).

A third type, also associated with the komatiite consists of scattered irregular shreds or inhomogeneously deformed clasts of serpentine in a carbonate matrix.

Porphyroblastic andalusite, cordierite, garnet and biotite schists form a brown weathering unit similar in appearance to the chocolate brown weathering ultramafic rocks in the eastern region.

Medium grained white quartzite forms prominent hills north of Laughland Lake and northwest of Walker Lake. These rocks are composed of glassy quartz grains with small amounts of muscovite and chromian muscovite and rare accessories such as hematite and allanite. In less quartzose rocks, layers of feldspar or alumino-silicates represent bedding with transverse foliation defined by oriented muscovite. Thin section examination reveals quartz with amoeboid and serrated grain boundaries. Locally the rocks are coarsened by recrystallization (annealing) to produce 3 mm quartz grains that contain oriented muscovite grains. All quartz grains show undulatory extinction in thin section and some have polygonized portions showing a bimodal grain size distribution. Kyanite in quartzites near Laughland Lake is broken and sheared and muscovite grains are gently crinkled. Andalusite in the quartzite near Hayes River is locally sheared. Bent and broken metamorphic crystals of quartz are strained, polygonized and annealed.

Most quartzites grade along strike into silky white quartzose muscovite schists, but other quartzites grade into feldspathic arenites (arkose?). Some quartzites have a calcareous matrix. Pyritic quartzites occur locally (LaPorte, 1974a,b). Arenitic rocks with small amounts of biotite and muscovite in a medium grained, quartzofeldspathic matrix are also present. Metamorphic medium grained rocks include mica schists, amphibolites, and rare carbonates. Mica schists containing abundant biotite and minor muscovite locally contain contorted and folded original layering. The amphibolites are composed mainly of actinolitic amphiboles, and accessory sulphides, magnetite, biotite, and quartz and/or calcite. Carbonates are present in the western region where they are represented by two-carbonate (calcite + ferroan dolomite) units several metres thick. In the eastern region rare occurrences of calcsilicate rocks contain epidote, clinopyroxene, quartz, plagioclase, and amphibole.

The fine grained rocks present mainly in the eastern region are grey or green, chlorite, actinolite, or biotite layered schists deformed in places by a strain slip cleavage. Amphibole rosettes (garbenschiefer) and some incipient porphyroblastic spots of plagioclase or kyanite-chlorite have developed locally. Some of the phyllites are chloritoid bearing. Very fine grained, laminated, black quartzose amphibolites which break with a subconchoidal fracture are classified as hornfels in the field. They consist of quartz, amphibole, minor biotite, and opaque minerals. The laminations in fine grained magnetite quartz rocks are usually planar, but irregular lenticles do occur. In some thin sections accessories such as tourmaline and apatite form thin laminae interlayered with quartz and magnetite lamellae. A well twinned clino-amphibole and a deep blue birefringent amphibole commonly occur together. A thermal study of Curie points of one of the iron formations from the eastern region suggests that pure magnetite and maghemite are present (Schau, 1975c). Hematite occurs with magnetite in iron formation in the western region.

Chemical analyses of each of the major rock categories are presented in Tables 5-11 and discussed in detail in the section in which the mode of origin of the Prince Albert Group is discussed.

Structural Relations

Internal Relations

Complex deformational features have been imposed on laterally variable sedimentary and volcanic rocks of the Prince Albert Group. Structural styles and metamorphism differ in the eastern and western regions.

North-south Fault System. The north-south fault system consists of at least two subparallel steeply dipping faults which parallel 92°30'W from 66°15' to 66°37'N. The relative displacement of the Prince Albert Group and the Brown River Gneiss Complex suggests that the apparent sense of movement is west side down. Minor folds and offsets on a related fracture cleavage which affects nearby rocks suggest a sinistral sense of movement along the fault. The fault trace is marked in part by fault breccias and intensive carbonate alteration, especially of the ultramafic schists.

The faulting, of probably middle Proterozoic age, offsets the Prince Albert Group, gabbro stocks and the Laughland anorthosite. Small gabbro plugs are emplaced along and foliated by the fault.

Eastern Region. Tight southwest-trending synclinoria (6b) with variable but mainly subhorizontal plunges characterize the Prince Albert Group in the eastern area. A cross section (Fig. 6c) of the synclinorium northeast of Walker Lake shows the apparent simplicity of the structure. A smaller fold, illustrated in Figure 6d, has a south plunge and clearly postdates the isoclinal folding. Minor folds associated with the isoclinal folding (Fig. 6e) are preserved in limbs of this smaller fold. This variation of complexity with scale is common. Minor folds (Fig. 6f) indicate many complex episodes of deformation but the large scale patterns are relatively simple, the belts representing isoclinal-synclinal keels of Prince Albert Group. More detailed mapping will probably emphasize the complexity of the smaller folds while preserving the concept of the simple, larger patterns.

Steeply dipping layering and foliation are generally parallel or subparallel to the edges of the belt. Rare areas do occur where some biotite grains outline the folded layers and others are parallel to the axial plane of the fold.

Near a few late granite plutons, two approximately normal biotite orientations can be seen. Some minor folds and lineations trending northeasterly are subhorizontal, others plunge steeply to the southeast. North of Hayes River very complex minor folds are related to the emplacement of a muscovite-bearing granite pluton (Fig. 7).

The metamorphic structures indicate that the rocks have been recrystallized under strain so stratigraphic thickness is not accurately known. Rough estimates of thickness and some data on the sequence and composition of beds are given (Table 3)*. The interbedded quartzites and pelites, the association of iron formations, and other iron-rich metasediments with the ultramafic units are well displayed along Hayes River southeast and east of point A (Fig. 1).

Western Region. Map patterns in the western region are more complex than those of the eastern region of the map area. The western region has been folded at least twice as is shown by minor folds superposed on each other, by lenticular distributions of rock units, by non-cylindroidal attitudes of layering, by folded foliation planes in gabbro stocks and by variable orientations of mineral lineations and minor folds. North striking, steeply dipping fracture cleavage has been superposed on previous structures near the eastern edge of region.

Layering and foliation are subparallel but, in many thin sections examined, the foliation is at low angles to the layering. Strain cleavage is especially common in the phyllites. Lineations are mainly due to intersections of tectonic planar structures and minor folds are present but not abundant.

A probable structural sequence from the area west of lake B (Fig. 1) in 56K/10 from the "oldest" to the "youngest" is: massive bedded quartzite, thick iron formation with interbeds of garnet, chloritic and/or amphibolitic schistose and granular quartzose layers, black biotite, chlorite muscovite schist, calcareous breccia with chloritic schist fragments, thin cherty iron formation, and massive chlorite actinolite rock which is probably ultramafic in composition. The thick iron formation outlines these complexly folded units.

To the north of lake B quartzose and biotite schists containing garnetiferous layers dip southward with medium dips. Farther north, the more schistose rocks are intruded by pegmatites now subhorizontally folded. The biotite schists and quartzose muscovite schists trend westward then southwest, where the dips steepen. Tectonic lenticles of ultramafic pods are included in the sequence near the change in strike.

Southwest of lake B a large gabbro stock and associated sills and dykes that cut the Prince Albert Group and the nearby Brown River Gneiss Complex are cut by later, small, biotite hornblende quartz diorite stocks and dykes. The Prince Albert rocks in this area are mainly clastic and dip east of northeast. Graded beds indicate that fragmental rocks with granitoid fragments set in garnetiferous and amphibolitic matrix underlie chlorite schists interbedded with quartzose mica schists. The fragments, as much as 40 cm long, 15 cm wide and 1 cm thick, are flattened and locally elongate down dip. Arrowhead-shaped flattened pebbles may represent multiply-strained fragments. A late east-southeast-trending "syncline" contains "spinifex" textured and crackled ultramafic units near its core (Schau, 1975b).

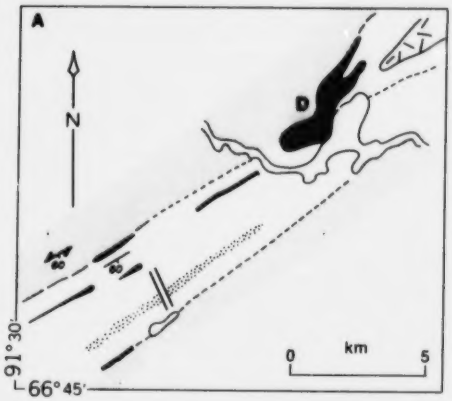
Northwest of Laughland Lake near the boundary between 56K/6 and 56K/3 quartzite and quartzose mica schist layers outline a large easterly-plunging syncline (Fig. 8). Near the core of this fold elongate basins of chlorite schists indicate that the region is multiply-folded but poor outcrop in the centre of the structure, the difficulty of assigning minor structures or foliations to a given fold episode, and the near absence of top determinations, precludes further structural interpretation (Fig. 8). A provisional stratigraphic section for this region is given in Table 4*.

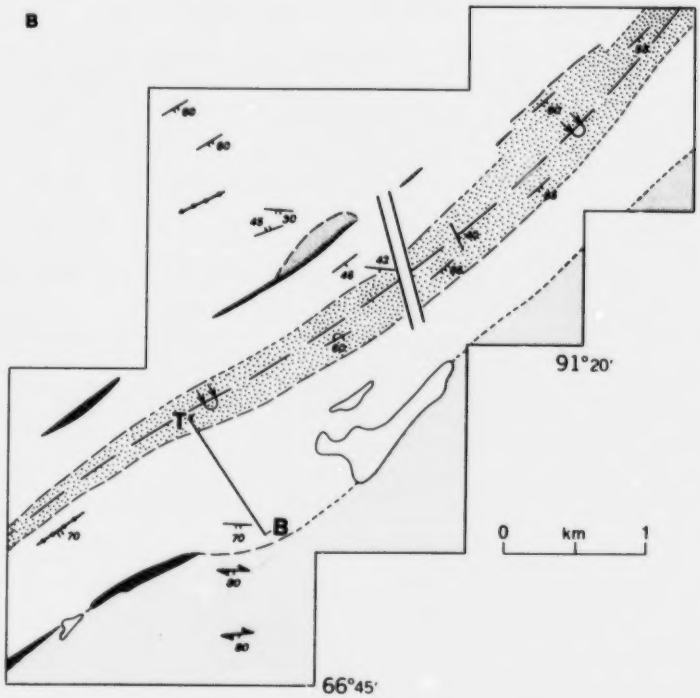
General. Examples of sedimentary facies changes include: resistant quartzite, hill-forming units that grade laterally to recessive muscovite schists and magnetic iron formation traced on aeromagnetic maps for many miles that vary in silicate or hematite-rich facies.

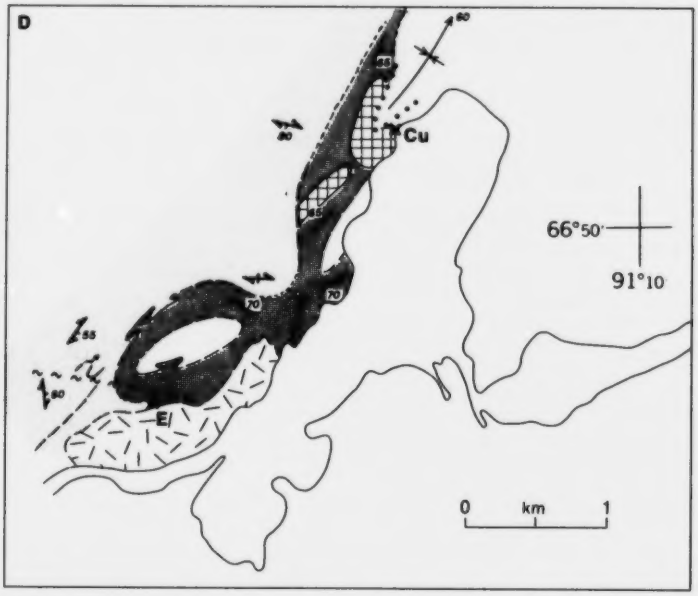
Ultramafic rocks occur as dykes, sills and flows. A dyke clearly crosses the sedimentary layering in NTS 56K/3 and east of Hayes River a sill retains medium- to coarse-grained relict textures. These units are locally extensively sheared. An ultramafic sill emplaced between sediments of the Prince Albert Group and the "underlying" gneiss (Fig. 3) contains a structural inclusion of Brown River Gneiss Complex gneiss. Ultramafic flows contain spinifex textures, crackling fractures, layering, and are interlayered with clastic rocks containing fragments of ultramafic rocks.

* Note: For Table 3 and 4 see page 45

Figure 6







Granite

Gneiss

Metagabbro stock

PRINCE ALBERT GROUP

Undifferentiated

Metakomatiite schist

Metadiabase dyke

Iron formation

Quartzite

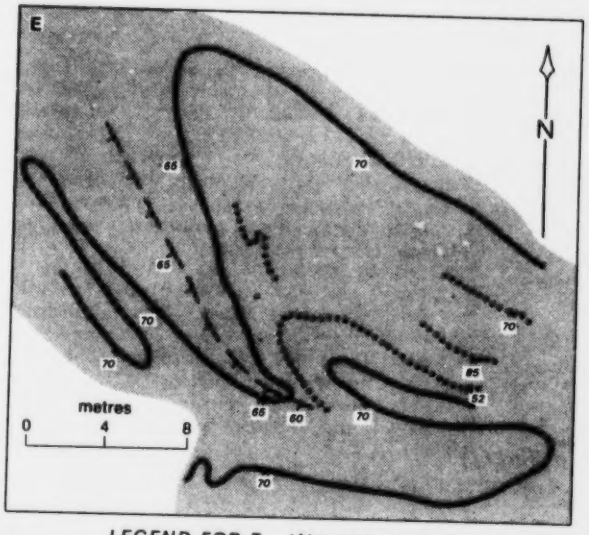
Bedding, tops known (inclined, overturned)

Bedding, tops unknown (inclined)

Gneissosity

Syncline (overturned)

Approximate location of section T B

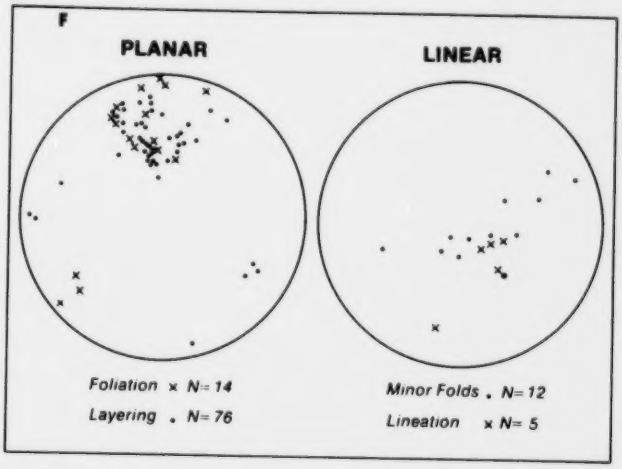


LEGEND FOR E (Also main legend)

Layer of serpentine-rich metakomatiite schist

Layer of tremolite-rich metakomatiite schist

Axial trace



A) Index map to sketch maps of different fold styles in eastern region.

B) Shows map of overturned isoclinal syncline developed in quartzite of Prince Albert Group.

C) Shows schematic cross-section on map B of isocline and relations with gneiss.

D) Shows map of complexly folded metakomatiite with late cross folds.

E) Shows detail map of minor fold. Note curved axial plane and opposite sense of rotation recorded by parasitic fold.

F) Structural elements on stereographic projections, showing large spread of linear structures and relatively homogeneous distributions of planar structures.

Figure 6

Ultramafic rocks, some of which are flows, are especially abundant in the vicinity of the north-south fault. In the core of the large fold near Laughland Lake relatively thin concordant ultramafic flows are interbedded with carbonates and iron-rich schists. In the eastern region ultramafic flow rocks of irregular thickness occur in the area near the muscovite granite. This eastern area is complexly deformed and therefore some of these variations may be of tectonic origin.

The thickness of the Prince Albert Group based on the matching of the iron formation and quartzite in the eastern and western areas is estimated to be about 2 km. In comparison, the estimated thickness for the Prince Albert Group on northern Melville Peninsula is about 7 km (Schau, 1977) and that of the Abitibi greenstone belt from 10 to more than 30 km (Baragar, 1968; Jensen, 1976).

External Relations

The relationship between the Prince Albert Group and surrounding gneisses is complex. In the eastern region rocks of the Walker Lake gneiss complex are conformable with or intrusive into the group, whereas in the western region the contact with the Brown River Gneiss Complex is marked by an intrusive body, faults, or in one place, an unconformity. At the unconformity vertically foliated tonalitic gneiss grades over 10 m into well layered vertically dipping metasedimentary rock containing flattened discs (pebbles?) of felsic composition similar to tonalite. One hundred metres away across the valley, within a matrix-rich arenite, rare crossbeds and ripple marks indicate that the sediment overlies the gneiss. In the western area ultramafic dykes intrude the Brown River gneiss and ultramafic sills contain gneiss inclusions, both facts constituting further indirect evidence that this gneiss is older than the Prince Albert Group.

The Prince Albert Group in the western region is generally a low grade metamorphic rock that rests unconformably on the degraded amphibolite facies Brown River gneisses. Near the Kellett Fault the metamorphic grade of the Prince Albert Group increases and contacts with gneisses become gradational or difficult to interpret. North of lake B (Fig. 1) schist and gneiss are in structural contact (Fig. 9). In the eastern region closer to a metamorphic high near Committee Bay (Schau, 1978), the Prince Albert Group and gneisses were plastically deformed and relationships are obscured. Gabbro, anorthosite, granitic plutons, metagabbro, later granitic plutons and Mackenzie swarm dykes intrude the group.

The Kellett River Fault system (Heywood and Schau, 1978) trends northeasterly through the area separating the Kuagnat Gneiss Complex to the northwest from the region which contains the Prince Albert Group to the southeast. The fault system is in part a steeply dipping zone across which neither Prince Albert Group structures nor rock types can be traced. The rocks in the fault zone are vertically dipping, finely laminated granitic gneisses. The fault zone of probable early Proterozoic age postdates the deformation and gneissification of the Prince Albert Group and is cut by a small undeformed granite plug which may be related to the "later" granitic plutons. No geological correlations have been made across the zone, therefore the sense of movement is not known.

The northwest-trending Hayes River fault (Heywood and Schau, 1978) has been inferred since units of the Prince Albert Group cannot be projected across a widened northwest-trending part of the Hayes River. Pockets of tectonic breccia have been found along the east shore of the river.

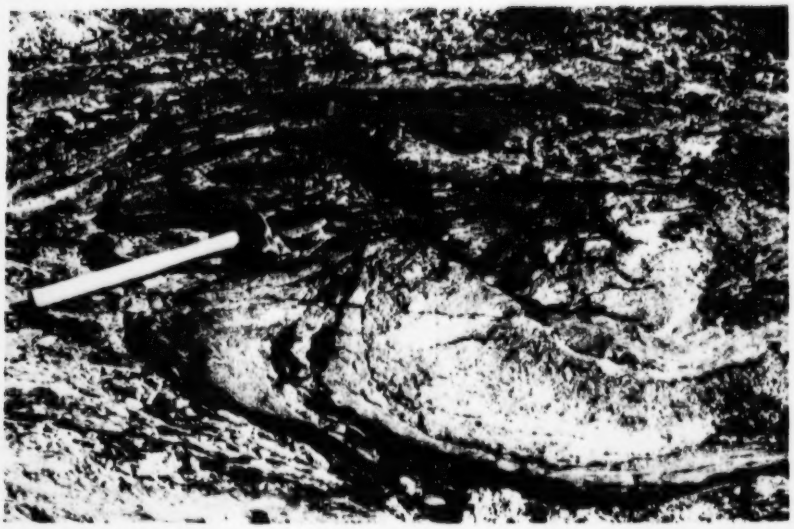


Figure 7

Photograph of complexly folded meta-komatiite schist of the Prince Albert Group within metamorphic aureole of muscovite granite. GSC 178405

One ultramafic unit could by coincidence be projected across river and this would negate the above statement, but in detail the ultramafic dyke on the southwest side of the river is in a vertical fault zone, whereas the ultramafic sequence on the northeast side of the river is part of a northwest-dipping supracrustal sequence of the Prince Albert Group. The nature of the movements has not been solved, but probably include a vertical component.

Structures near a small fault 4 km northeast and subparallel to the Hayes River fault are not simple, and enough movement has occurred to make matching of units across fault difficult. Relative movement deduced from matching aeromagnetic patterns suggests an apparent right lateral movement of 2 km.

The age of these northwest-trending faults in the eastern region is not well known. The faults cut the deformed Prince Albert Group and the Kellett Fault zone but not the "later" granitic pluton. The early Proterozoic gabbro dykes are intruded in the fault zone. The fault is probably early Proterozoic in age although minor later movement may have occurred. In the western region north-northwesterly trending faults bring quartzites of the Prince Albert Group against granitoid gneisses of the Brown River Gneiss Complex. The fault zones, marked by intensely sheared quartzites, are lost under the extensive drift cover.

Metamorphism

Metamorphic grades in the Prince Albert Group increase northeasterly to a metamorphic culmination near Committee Bay (Schau, 1978). The western region is composed of phyllites and associated rocks containing upper greenschist facies mineral assemblages, whereas the eastern region is composed of mica schists and associated rocks of lower amphibolite grade.

Phase assemblages from each of the regions were plotted on an uncalibrated petrogenic grid. Although the topologies of the grids are generally accepted, the numerical calibrations are not accurate because they are without reasonable estimates of variance (Zen, 1977). When variance estimates are made it becomes apparent that the petrogenic grids do not provide reliable boundary conditions to tectonic models (Schau, 1978).

Textures

In the west, foliations expressed as cleavages accentuated by mica or chlorite flakes, form chlorite schists or pelitic phyllites. In the east, foliation is well developed in mica schists and is locally oblique to compositional layering, and in some places micas with new orientations have grown across the first foliation. Strain slip cleavage and fracture cleavage were locally noted. Minor folds in a variety of shapes and orientations, including detached fold noses, give the rocks a discontinuous aspect on hand specimen to outcrop scale.

Mineral growth differs in the western and eastern regions. Small plagioclase and kyanite knots developed in the west, whereas andalusite and tourmaline form decimetre sized porphyroblasts in the east. Rosettes of Actinolite (garbenschiefer) occur mainly in the western region as do carbonate porphyroblasts. In the east biotite porphyroblasts have grown across the foliation and garnets form irregular aggregates or crystals. Eckstrand (1975b) has noted degraded bladed olivine crystals that developed across sheared metamorphic minerals in the volcanic rocks. In most thin sections there is evidence of two or more episodes of mineral growth. There is some evidence that mineral grains have been polygonized in the quartzites. In particular, there is a variation in grain size and, although some of this may be due to variations in primary sediment size, it can also be shown that polygonization has affected individual quartz grains.

Minerals

The fine grained opaques in the serpentine are thought to be magnetite (based on a Curie point of 580°C for a meta-ultrabasic rock containing such grains), but X-ray work on powdery coatings in a peculiarly green, serpentine specimen yielded an indication of a nickel hydroxide, suggesting that some of this fine grained material may well have been native nickel. If native elements (nickel and iron are often associated) are present, then the FeO contents of these rocks will be overestimated by three times the amount of native iron present, and the "correct" Fe_2O_3 contents should be correspondingly increased in analyzed specimens. Many whole-rock X-ray diffractometer traces have a poorly developed peak at magnetite, but none of awaruite. Native elements have been described by many authors from serpentinites and seem to be one byproduct of serpentinization (Eckstrand, 1975a), whereas magnetite may in part by the result of a higher temperature process (Moody, 1976).

The problem awaits further work, but although native elements may be present it is thought that the majority of the fine grained products are magnetite. Most of the sulphides are pyrite, but locally pyrrhotite and chalcopyrite are present.

Chloritoid has been identified optically and by X-ray and is locally abundant in the western part of the area. Cordierite is present in the east of the area; in the west poikiloblastic porphyroblasts of plagioclase resemble the habit of cordierite in thin section. Various amphiboles are present; optical examination plus a limited amount of X-ray work confirms the large variety but does not provide accurate estimates of their composition. The suspected presence of two amphibole phases in a rock can be confirmed by split peaks in X-ray diffractometer traces over the range 20=10-11° (Cu radiation). The routine optical determination separated acicular rosettes of "hornblende", finely twinned clino-amphibole, "cummingtonite", tremolite, actinolite, common "hornblende" and other calcic-amphibole, and a blue pleochroic clino-amphibole which is probably sodic "riebeckite". In some rocks many of these phases are present. Needles of orthorhombic amphiboles are probably anthophyllite.

Talc, and an alteration phase determined on X-ray diffractometer patterns with a pattern closely similar to that of "palygorskite", have been noted. Chlorite and antigorite are differentiated on the basis of X-ray diffractometer patterns in critical mineral assemblages. Although mesh and vein serpentine were noted in thin section, no confirmation exists on X-ray patterns for the presence of chrysotile and lizardite and much of this material may be antigorite. Clay minerals may be present. A 2θ peak near 5.8° (copper radiation) is sometimes found associated with chlorites, suggesting a small amount of "montmorillonite" or "weathered chlorite". Carbonates identified include magnesite, dolomite and calcite. In places all three phases are present in one thin section.

Mineral Assemblages

Similar rocks in the western and eastern regions are composed of different mineral assemblages. Greenschist facies phyllites and green, fine grained schists are the dominant rock types in the western region, whereas amphibolite facies porphyroblastic mica schists are dominant in the eastern area. The western group is characterized by kyanite-bearing arenites and pelites whereas the eastern area is characterized by andalusite-bearing arenites and pelites.

The phyllites are composed mainly of chlorite-biotite-white mica-quartz or chlorite-actinolite-biotite-quartz assemblages with varying amounts of plagioclase. Pelitic phyllites may contain kyanite-chlorite-quartz-muscovite or garnet-chlorite-biotite-quartz-muscovite assemblages. Quartzite units contain quartz-muscovite-chromian-muscovite-kyanite assemblages with accessory tourmaline and rare zircons. Ultramafic sills, dykes and flows contain chlorite, tremolite and antigorite with carbonate (usually ankerite, dolomite) porphyroblasts and talc and/or fine grained magnetite. The pelitic assemblages are plotted on an AFM diagram (Thompson, 1957; Fig. 10).

Somewhat higher grade rocks occur near the Kellett River Fault and in a narrow aureole around a quartz diorite stock. The higher grade rocks, coarser grained and with deformed sedimentary layers, contain staurolite-biotite-quartz-muscovite and garnet-biotite-potash feldspar-quartz-muscovite assemblages. The aureole intersects a quartzite unit and the mineral assemblage at the contact is kyanite-muscovite-quartz with rare garnets. If this kyanite is stable it indicates that the pluton was emplaced at considerable depth. Further, if the aureole and the higher grade assemblages represent the same grade, they can be shown on an AFM diagram (Thompson, 1957) (Fig. 10).

The pelitic assemblages are characteristic of greenschist and amphibolite facies rocks metamorphosed at pressures greater than that of the triple point of the aluminosilicates.

On an uncalibrated grid such as that devised by Ermanovics and Froese (1978) these assemblages would lie along track A1-A2 (Fig. 11).

In the eastern region lower amphibolite facies pelitic rocks contain chlorite and the apparently coexisting assemblages: muscovite-quartz-cordierite-staurolite-garnet-biotite. (Schau, 1978). Staurolite disappears to the northeast along strike. Locally, pelites contain andalusite-cordierite-biotite-quartz-muscovite and opaque mineral assemblages. Quartzites contain quartz-muscovite and andalusite. Carbonates are composed of calcite and skarn minerals such as epidote, zoisite and clinopyroxene, and rarely, diopside and microcline. Amphibolites mainly consist of brownish green hornblendes with opaques, biotite, plagioclase and/or minor quartz. Ultramafic flows, dykes, and sills are composed of antigorite, tremolite, chlorite, olivine, and opaques. Commonly the olivine has been degraded to serpentine. Biotite or phlorgopite may replace some of the chlorite or serpentine. Talc is present in some chlorite-tremolite-serpentine rocks.

These amphibolite grade assemblages may have formed at lower pressures than assemblages to the west (Schau, 1978). The pelite compositions, when plotted on an AFM diagram (Fig. 10), show two different sets of amphibolite facies conditions. If the low variance rock actually formed at equilibrium it would plot on the uncalibrated grid at B1Y (Fig. 11), however if the chlorite is a secondary alteration product the assemblage may be represented by a point on the "univariant" line B1Z (Fig. 11). Locally, higher grade conditions are represented by coexisting biotite, andalusite and cordierite with quartz, muscovite and opaques (B2, Fig. 11). Near the Kellett River Fault zone higher grade assemblages occur with sillimanite and hercynite.

The tracks (A1-A2 and B1(xyz-B2) define in a relative sense the intensity of metamorphism. Temperature ranges are equivalent for both regions but the pressure range may differ.

State of Oxidation of Rocks of Map Area. All ferric ferrous determinations for the Prince Albert Group in the map area are plotted on Figure 12. The rocks contain the one to three ratio characteristic of metamorphic rocks.

Investigation of the mineral assemblages of the Prince Albert Group show that there are assemblages which indicate variations in oxygen activity in the region during metamorphism. For example, magnetite-pyrrhotite occurs near the anorthosite intrusion whereas specular hematite-magnetite is present along strike. Not all metamorphic rocks contain iron oxides or pairs of silicates which serve to buffer the oxygen activity. However, most contain at least one iron silicate with some accessory oxides. Many iron silicates, particularly hydrous ones, have variable ferric ferrous ratio and hence variable oxygen contents.

Low ferric ferrous analytical ratio (1:7) of the bulk rock is associated with the presence of iron-rich chlorites in the rock whereas the high (1:3) analytical ratio is associated with magnesium chlorite, suggesting that if pressure and temperature gradients were relatively constant in each of the areas then these changes would be due to variations in the oxidation of the rock.

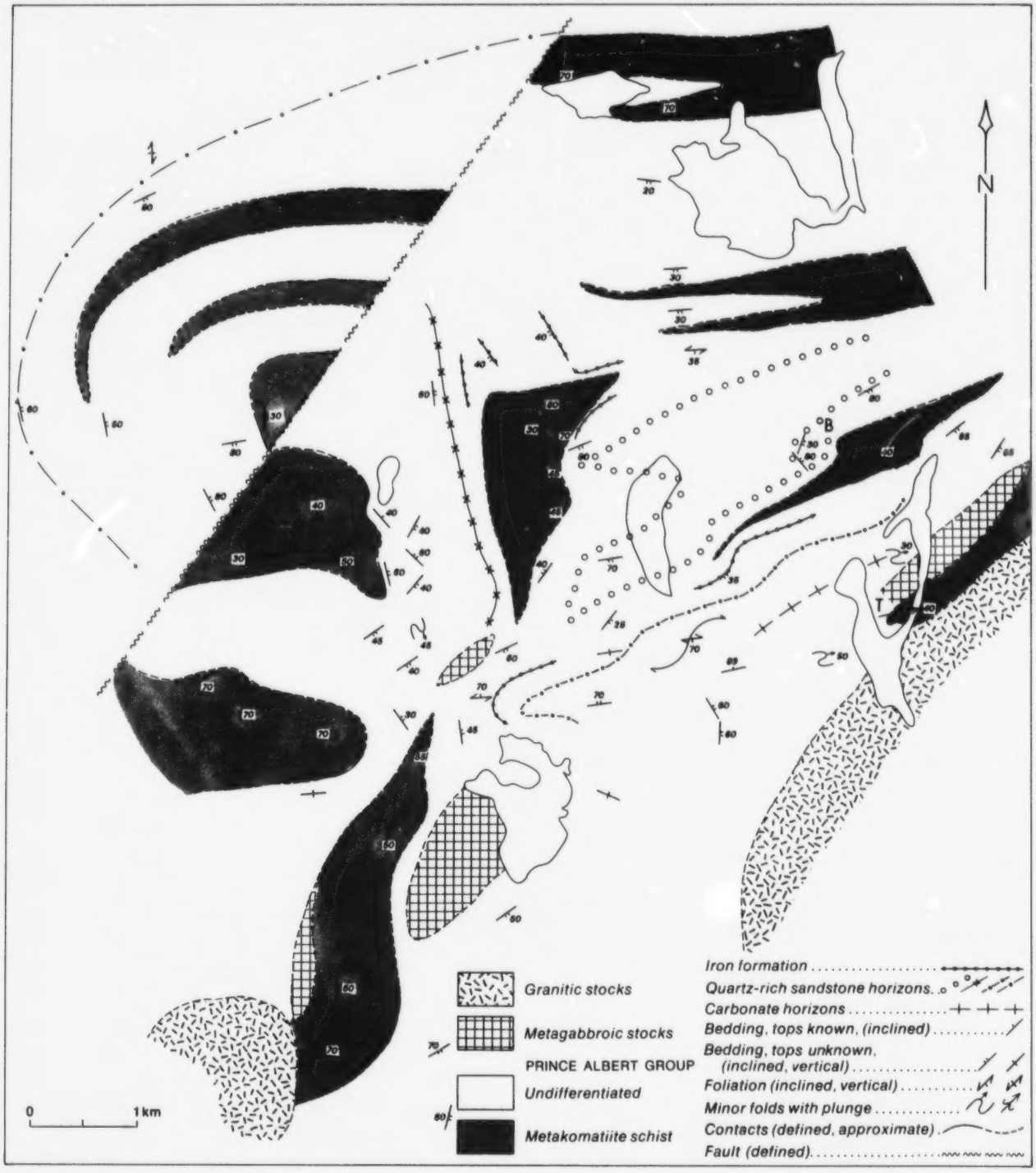
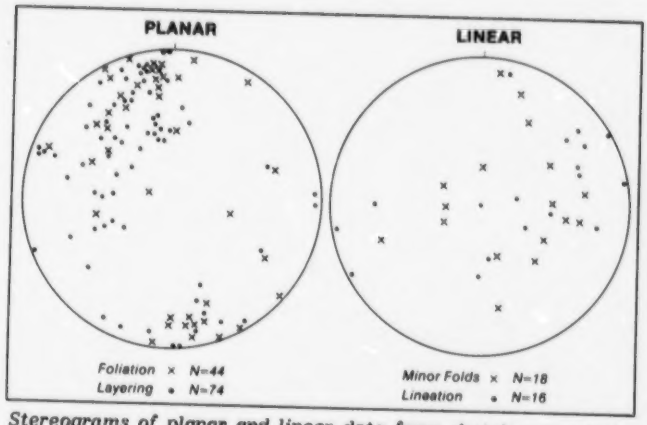


Figure 8. *Sketch map of region northwest of Laughland Lake (56K/6) showing complex refolded structures developed in Prince Albert Group. Note relatively open style compared to structures in Figure 6. B-T is line of section.*



Stereograms of planar and linear data from sketch map. Note divers orientations of minor structures indicating probability of several fold episodes.

Figure 8

Figure 9. *Photograph of structural break between gneisses and schists near northern boundary of Prince Albert Group. GSC 178353*

In the eastern region the iron once in the pyrogenetic minerals such as olivine of the metavolcanic rocks is now in magnetite, whereas in the western region this iron is now mainly in talc, serpentine and carbonate. Low grade alteration products of olivine do not contain magnetite (Martin and Fyfe, 1970; Moody, 1976). In a carbonated environment it is assumed that brucite formed in such a reaction would be replaced by ankerites or iron-bearing magnesite facies at low temperatures. Magnetic susceptibility, a rough measure of magnetite contents of ultamafic rocks is variable throughout the region, varying from none to about 11 per cent magnetite (30 SI to 3130 SI units) and some values for individual samples are indicated in part three of Tables 5 and 6.

No graphite has been observed in these fine grained metamorphic rocks but graphite has been noted in sillimanite-bearing rocks of the Prince Albert Group near Ellice Hills (Campbell, personal communication, 1973). Minor amounts of "non-carbonate" carbon have been found in chemical analyses from a suite of rocks from the western area (see Tables 5-11). There is an inverse relationship between oxidation state and amount of non-carbonate carbon. Thus the possibility that oxidation of sedimentary carbon has led to the reduced iron ratios cannot be precluded (Thompson, 1972).

Summary of Metamorphic Conditions

The Prince Albert Group has been variably metamorphosed. In the west the rocks are crushed and kyanite-bearing; phyllites are the characteristic rock types. In the east the rocks are recrystallized; and andalusite-bearing porphyroblastic schists are the characteristic rock types. Utilizing current petrogenetic grids (Ermanovics and Froese, 1978) it is possible to suggest that the western region was deformed at higher pressures than was the eastern region but at very similar temperatures (Schau, 1978).

A variety of iron mineral assemblages suggests that oxygen fugacities were locally determined but the presence of carbon and the generally reduced iron ratios suggest that oxidation of graphite to carbon dioxide was an important process in these rocks. The presence of carbon raises the possibility that methane was an important constituent of the metamorphic fluid. Hence, confining pressure and water fugacities would not be equal (Frey, 1978; Eugster and Skippen, 1967) and the pressure differences postulated above and in Schau (1978) may be diminished although not removed entirely.

Fisher (1977) has argued that the formation of crystal seeds is a function of metamorphic reactions between silicates and components of aqueous fluids, whereas the size of the crystal is a function of the ease of diffusion of appropriate components. Growth is enhanced by increased temperature and by strain-induced recrystallization which yields polygonized grain and release-trapped volatiles to facilitate diffusion along grain boundaries.

If ambient temperature was approximately the same for the two terranes then the "lower-pressure" rocks with the abundant large porphyroblasts which lie on the upward side of a dehydration curve would be in an environment of enhanced volatile pressure, whereas the rocks in the "higher-pressure" terrane which contain polygonized minerals and growth of small crystals along foliation planes and a suggestion that methane was a component of the fluid, would be in a "dryer" environment. In this case dehydration reactions which enhanced volatile pressures in this low pressure environment were more effective than an increase in surface area of reacting grains in a medium pressure environment in producing large porphyroblasts. The temperature may in fact have been slightly higher in the lower pressure environment to enhance recrystallization.

If the size of porphyroblasts is governed by diffusion rates then it is an indication of how long relevant metamorphic conditions were active. The large (as much as 5 cm long) porphyroblasts of andalusite with biotite present near Hayes River are somewhat like the Vaestervik segregations described by Fisher (1977). He estimated that the Vaestervik segregations which have core radius of about 0.5 cm, took about 66 000 years to form by diffusion processes. If all assumptions made by Fisher (1977) also hold for the Hayes River andalusites, then approximately 0.75 to 3 million years would be necessary for the growth of these porphyroblasts (Fisher, 1977, p. 399).

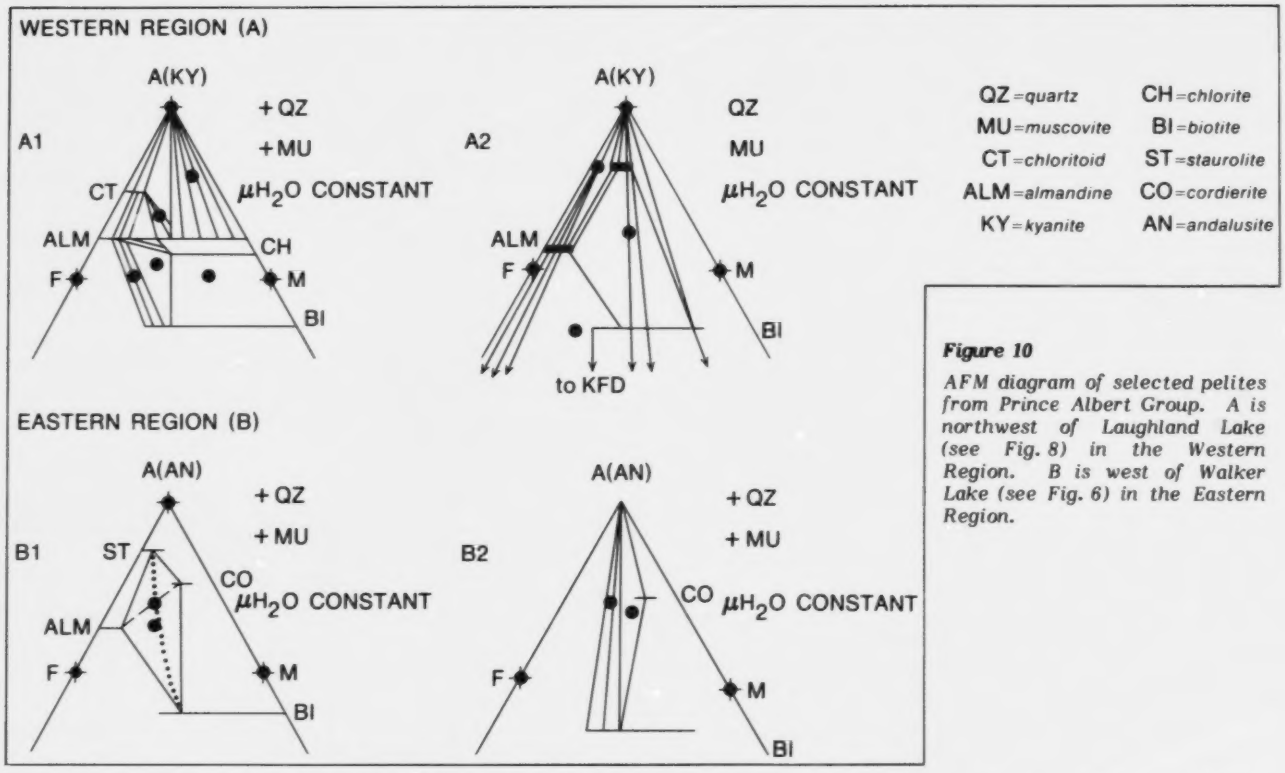


Figure 10

AFM diagram of selected pelites from Prince Albert Group. A is northwest of Laughland Lake (see Fig. 8) in the Western Region. B is west of Walker Lake (see Fig. 6) in the Eastern Region.

This estimate suggests that the peak of metamorphism was short (about 10 Ma) whereas the usual length for an orogenic episode is about 100 Ma (Fisher, 1977) or 200 Ma (Sutton, 1967). It is suggested that metamorphism waned after a peak in late Archean time.

Mode of Origin

Chemical data from the map area have been used to construct a model to explain the coexistence of ultramafic lavas, iron-rich sediments and quartzites. The results are compared to recent examples of subaerial and lacustrine continental deposits. This reconstruction of environment of deposition of the region using bulk chemical analysis and only a few relict sedimentary structures as a guide is speculative and is discussed in detail in a following section.

Age and Correlation

The age of the Prince Albert Group is not known in the area but components on Melville Peninsula are of late Archean age. Direct evidence of the age in the mapped regions gives minimum estimates only. Potassium-argon dates on biotites of rocks of the Prince Albert Group in the map area are middle Proterozoic (Table 12)*. Amphiboles are somewhat older and a tourmaline in a metamorphic aureole yielded the oldest date for the region (2342 Ma). Intrusions into the Prince Albert Group yield late middle Proterozoic dates.

More detailed examination of mineral and rock separates of a biotite-bearing ultramafic indicates that considerable excess argon was redistributed among the minerals to give spurious dates (Table 12). The apparent date of recrystallization was 1575 Ma. Wanless (personal communication) estimated that if the system was always closed and all simplifying assumptions were true (a most unlikely event) then the excess argon of the rock would indicate that the parent rock, a komatiite, was about 2700 Ma old.

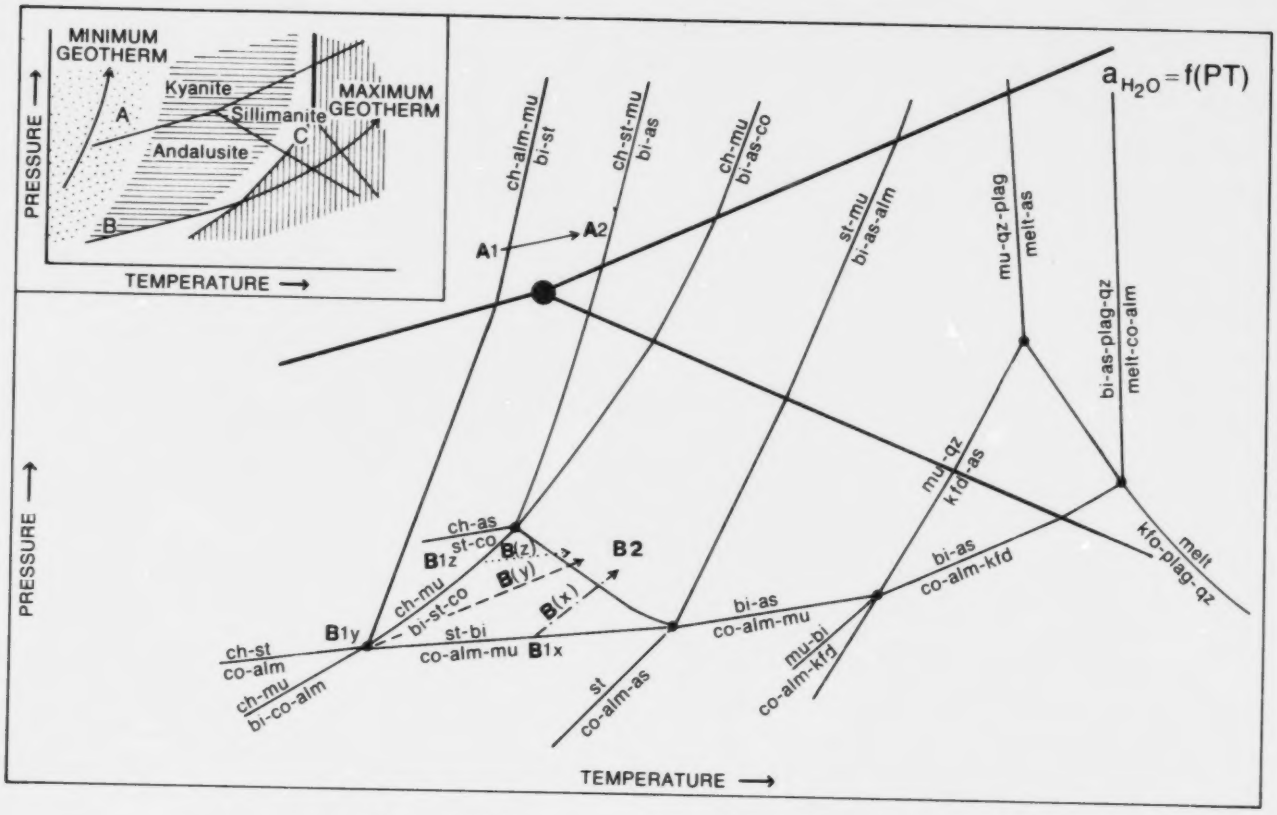
On the basis of these sparse radiometric studies it can be concluded that the Prince Albert Group has simmered near or above the blocking temperature of various minerals for a long time or several times to account for the systematic differences of mineral ages and redistribution of excess argon and that this cooking ceased in middle Proterozoic time.

The time of deposition of the Prince Albert Group is more difficult to estimate. The rocks are part of the gneiss terrane which apparently underlies the Chantrey Group to the north (Heywood, 1961), and the Amer Group to the south (Heywood, 1961, 1977) and must predate the metamorphism and deformation of this gneissic terrane.

On Melville Peninsula, gneisses were formed from the Prince Albert Group about 2605 Ma (Schau, in preparation). A discordant lead-lead ratio on zircons from acid volcanic rock of the Prince Albert Group indicates a minimum age of 2738 Ma, and a discordant uranium-lead on zircons from the same acid metavolcanic unit yields a minimum age of 2937 Ma (Wanless, 1979). Grey gneisses, supposedly older than Prince Albert Group on southern Melville Peninsula, give ages of about 3000 Ma (Wanless, 1979). Thus the Prince Albert Group is probably between 2700 and 3000 Ma and nearer the latter in age.

The correlation across Committee Bay (Heywood, 1961, 1967) is based on the projection of units along strike. Detailed lithological correlations include chromian muscovite-bearing orthoquartzites and occurrences of spinifex textured magnesian volcanic rocks on both sides of the bay. The Prince Albert Group on Melville Peninsula is also shown to be part of the basement to the Penrhyn Group.

* Note: For Table 12 see page 55



Ch	= *chlorite*	*as*	= *unspecified aluminosilicate*
alm	= *almandine*	*co*	= *cordierite*
mu	= *muscovite*	*qz*	= *quartz*
bi	= *biotite*	*plag*	= *plagioclase*
st	= *staurolite*	*Kfd*	= *potash feldspar*
dots	= *greenschist*		
	horizontal lines	= *lower amphibolite*	
	vertical lines	= *upper amphibolite*	

Figure 11. *Uncalibrated petrogenetic grid (after Ermanovics and Froese, 1978) with relative positions of studied metamorphic mineral assemblages. Region A is near Laughland Lake; Region B is near Walker Lake; A1, A2, B1 and B2 are assemblages studied - see text for discussion. No numbers have been put on pressure or temperature axes since the role of components in fluid phase is not understood. Inset is summary from Schau (1978) showing minimum and maximum geotherms deduced for Prince Albert Group in District of Keewatin.*

The age of deposition of the Prince Albert Group is thus considered to be late Archean. The main deformation and metamorphism probably occurred at the end of Archean time. It was intruded by early to middle Proterozoic dykes and plutons and affected by shearing and jostling accompanying the movement of the large, province-wide, fracture systems.

In recent years a number of late Archean formations that are not lithologically similar to the Prince Albert Group in central Keewatin have been described from northern Canada. They include the upper Archean Kaminak Group characterized by large mafic tholeiitic plates mantled by calcalkaline carapaces of the Ennadai-Rankin Belt to the south (Ridler and Shilts, 1973), and the locally acid or basic volcanic rock and greywacke turbidite sequences of the upper Archean Yellowknife Supergroup (Henderson, 1975; Lambert, 1977). These variations in lithologic associations presumably reflect differences in depositional environments which may be linked to differences in deeper seated conditions. That these different depositional environments existed during the latter part of the Archean seems clear, but whether they had the same geographical relationships as we now see will undoubtedly be determined by further work on the amount of offset of the great shear systems of the Churchill Structural Province (Heywood and Schau, 1978). On the other hand, quartzite and chlorite schist of the Tazin Group (Tremblay, 1968) may be late Archean in age. Further work may indicate that similar units of similar age exist in the intervening region.

The rock assemblage of the Prince Albert Group in the map area is unusual among Canadian Archean rocks, but examples of this rock suite are known from the Archean of the African and Indian landmasses. The Wedza schist belt (Zimbabwe) of probable Buluwayan age (Archean) contains ultramafic volcanic dykes, sills and flows interlayered with iron formations, micaceous schists, fuchsite quartzites, calcsilicate schists, and unusual rocks such as corundum, andalusite, fuchsite rock locally called corundum granulite and cordierite-gedrite-cummingtonite schists (Fey, 1976).

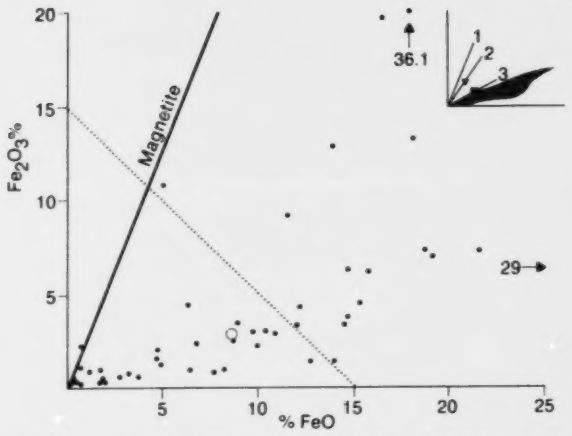


Figure 12. Plot of oxidation state of metasedimentary rocks of Prince Albert Group. Open circle is ratio in average komatiite. Iron formations are above and to the right of the dotted line and the ratio seen in magnetite is shown by the solid line. Inset shows lines formed by ratio of iron oxides in magnetite (line 1); in Clarke's (1924) average shale (line 2); and in Shaw's (1956) high grade pelite (line 3). Clearly, the Prince Albert Group is more reduced than Clarke's average shale and very near Shaw's high grade pelite, as is shown by the patterned area.

The Archean Sargur schist complex in southern Karnataka (India) is composed of thin interbedded fuchsite and chromite-bearing quartzites, pelites, basites, carbonate rocks, spinifex-bearing ultrabasites and iron formations, and is associated with anorthosite and anorthositic gabbro (Viswanatha and Ramakrishnan, 1975; Viswanatha et al., 1977; Radnakrishna and Vasudev, 1977; Ramiengar et al., 1978).

The worldwide, though relatively uncommon distribution of rock assemblages like the Prince Albert Group, indicates that their environment of deposition is not unique. Each of the groups appears to be enclosed in the gneissic terranes and may have undergone similar subsequent histories.

Gabbro Stocks

Distribution

Gabbro stocks intrude the Brown River Gneiss and the Prince Albert Group. The largest underlies about 100 km^2 southwest of lake B, but other smaller stocks are widely scattered and they are associated with komatiites and iron formations in many places. In the western region they are easy to distinguish from the country rock, whereas in the eastern region they are deformed and amphibolitized and smaller bodies are probably included as amphibolite layers in the Walker Lake Gneiss Complex.

Lithology

Metagabbro from the largest body (southwest of lake B, Fig. 1) is medium- to coarse-grained although porphyritic phases with either hornblende or plagioclase phenocrysts are present. This stock is sheared and rocks from the shear zones are biotite-bearing, generally schistose, and contain abundant transecting epidote and/or quartz-carbonate veins. Near contacts the rock becomes fine grained and blue-black in colour.

In the western area relatively massive, fine- to medium-grained metagabbro is variable sheared and carbonated and locally grades into chloritic phyllonite zones. Amphibole rosettes that developed across these zones in the vicinity of later granitoid plutons are undeformed. Thin section analysis reveals that recrystallized sheared metagabbro contains labradorite and hornblende relicts set in quartz plagioclase and actinolite chlorite mosaics speckled with fine grained oxides, pyrite, chalcopyrite and carbonates. A chemical analysis (Table 3, no. 1) indicates that a sample from a stock is somewhat more iron-rich and magnesia-poor than normal gabbro (Table 13, no. 16) and that carbonate has elevated the lime content so that the analysis cannot be taken to represent the magma from which the stock crystallized.

In the eastern area the stocks have been altered to amphibolite-rich gneissic domains in granitoid gneiss. Recognizable stocks are found north of the lake where the Kellett River crosses the outcrop belt of the Prince Albert Group and south-southeast of point A (see Fig. 1). These stocks are intimately associated with komatiite accumulations. Thin section analyses reveal that they are composed of relict labradorite and zoned amphiboles set in quartz plagioclase mosaic and intergrown with biotite and/or chlorite-speckled porphyroblastic hornblende with sphene and speckled with epidote and/or carbonate. Some rocks are especially rich in epidote. The chemical variability of hand specimens taken from two stocks (no. 8-11 and no. 12-16, Table 13) is rather high, due in part to igneous differentiation producing an iron enrichment trend and in part to local metamorphic differentiation ((no. 11, Table 13) is especially enriched in epidote).

East-southeast of Point A (Fig. 1) a coarse hornblende plagioclase unit in the Walker Lake Gneiss Complex which probably was a gabbro stock into mafic gneiss by diminution of grain size, lessening of mafic content and increase of potash content (no. 7, Table 13).

North of Point A (Fig. 1) an amphibolite interpreted to be a multiply-deformed stock within the metamorphic aureole of a muscovite granite consists of granoblastic textured amphiboles, plagioclase and sphene. Near this unit an apparently conformable actinolite schist which consists of relict plagioclase set in quartz-plagioclase mosaic and abundant actinolite dotted with opaques probably represents another small stock.

Small gabbro stocks found in the north-south faults are composed of medium- to fine-grained plagioclase, hornblende and opaque minerals which grade into sheared equivalents now composed of plagioclase, chlorite, actinolite, biotite, quartz ± sphene ± carbonate ± garnet.

Structure

Internal Relations

The largest gabbro stock retains well preserved massive gabbroic textures and contains relict fragments of iron formation and Brown River(?) gneiss. It is locally intensely-sheared by steeply dipping, east-northeast striking shear zones that are as much as 20 m wide. Several generations of carbonate, quartz or epidote veins are in or near these shear zones. Stocks in the western area also show massive gabbroic textures, contain inclusions of Prince Albert Group komatiites and phyllites, and are cut by carbonate-bearing shear zones.

The amphibolitized stocks in the eastern area are gneissic but contain relict patches of gabbroic texture and inclusions of quartzite, gneiss and metakomatiite.

External Relations

The large stock intrudes the Prince Albert Group and is intruded by pegmatitic veins and, on its southern and eastern borders, by a relatively fresh quartz diorite stock. In the western area the stocks intrude the Brown River Gneiss and the Prince Albert Group. Gabbro units in the cores of an easterly plunging fold are intensely sheared. In the eastern area the stocks have discordant relations with the Prince Albert Group, but in gneissic regions the contacts are generally concordant. They are cut by garnetiferous muscovite granite plutons and pegmatites and by a later dyke. In the north-south fault small gabbro stocks are emplaced along, but sheared or locally foliated by, the fault system.

These relationships suggest that the gabbro stocks were emplaced after the formation of the Brown River Gneiss Complex and after the deposition of the Prince Albert Group. The stocks were emplaced prior to the east-plunging folding, formation of the Walker Lake Gneiss Complex and emplacement of granitoid stocks and associated pegmatites.

Metamorphism and Mode of Origin

The largest body contains greenschist grade mineral assemblages in its sheared portions, but the massive areas are apparently relatively unmetamorphosed.

The western region stocks contain a few labradorite relicts but most of the unit is of greenschist grade, being composed of varying proportions of carbonate, epidote, chlorite and actinolite, and accessories.

The eastern region stocks contain the somewhat higher grade minerals oligoclase and tan-green pleochroic hornblende and sphene with local areas of greenschist grade assemblages. The textures are locally granoblastic.

These features suggest that larger gabbro bodies maintain their textures and some of their mineralogy whereas the smaller stocks are more completely metamorphosed. The western region stocks are greenschist grade; the eastern region stocks are amphibolite to greenschist grade, a parallel pattern to the metamorphism in the Prince Albert Group. The dyke-rich border and finer grained margin of the largest body, the discordant contacts and the presence of angular inclusions in the stocks, indicate that the stocks were emplaced in a relatively shallow crustal environment.

Age and Correlation

The gabbro stocks intruded Prince Albert Group and most were emplaced prior to east-northeast trending deformation, the formation of Walker Lake Gneiss Complex and the plutonic activity.

Minimum K-Ar dates on biotite and hornblende from one sample of a gneissified stock in the eastern region are 1605 Ma and 2223 Ma respectively (Table 12, no. 7, 8). The older date probably represents the time of cooling of the Walker Lake Gneiss Complex or some hybrid date rather than date of emplacement of the stocks. The younger date reflects cooling past the biotite blocking temperature during uplift or recrystallization of the biotite during regional shearing.

The gabbro stocks are possibly correlated with the Tasijuag gabbro complex on Melville Peninsula (Schau, in preparation).

Laughland Lake Anorthosite

Name and Distribution

The Laughland Lake anorthosite complex, consisting of a main body and dykes, is exposed north of Laughland Lake. About 50 km^2 was mapped north of 92°30'W and 66°15'N. The southern boundary was not mapped.

Lithology

Anorthosite and gabbroic anorthosite consists of coarse grained, locally granular, closely packed plagioclase crystals, in places rimmed by mafic minerals. They weather a chalky to greyish white to a pale yellow or pale pistachio green colour with thin, darker green amphibole laminae. Although cumulate textures were not seen in place, glacially transported anorthosite boulders (as much as 40 km to the north) contain euhedral plagioclase crystals several centimetres long in a cumulate mafic matrix.

In thin section the unit is seen to consist of calcic labradorite now altered to albite and zoisite or epidote; mafic minerals are completely altered to hornblendic or actinolitic amphiboles. Two chemical analyses (Table 14) illustrate the calcic nature of the anorthosite.

Structure

Internal Relations

The anorthosite is layered and deformed, and two sets of minor folds of opposite sense (S on Z) are superposed on each other. It is locally very fine grained such as in the dykes to the east where it is more degraded than in the main mass.

External Relations and Metamorphism

The northern contact of the larger anorthosite body is not well exposed but it appears to cross quartzite, iron formation and metagreywacke of the Prince Albert Group. The dykes intrude the Brown River Gneiss Complex. The relationship with the nearby amphibolite (metagabbro) stock and dykes is not known. The anorthosites are degraded and now contain assemblages characteristic of greenschist or lower amphibolite metamorphic facies. The large north-south fault system appears to form the eastern boundary of the main mass. East of this fault system only the dykes have been recognized.

Mode of Origin

Crosscutting features of the anorthosite suggest that the emplacement was magmatic. The very calcic nature of the rocks suggests extremely high temperatures for the magma but no contact metamorphic features were seen. Sulphide pods near the anorthosite are pyrrhotite-magnetite rather than pyritic, as is usual in the region, but whether this is a feature of the contact aureole has not been established.

Age and Correlation

The complex cuts Prince Albert Group and Brown River Gneiss Complex. The low to medium grade of metamorphism of the Laughland Lake anorthosite suggests it was emplaced prior to the regional metamorphism. It has been deformed twice and was therefore emplaced before the main deformation. It appears to be displaced by the north-south faults. It is therefore probably late Archean in age.

This is in the same time span as the gabbro stocks were emplaced.

Gneisses

Introduction

The Walker Lake Gneiss Complex and the Kuagnat Gneiss Complex were formed after the deposition of the Prince Albert Group, and in part incorporate rocks of the

Prince Albert Group. Although there may be more than one gneiss-making process, and although there is evidence that gneiss was generated at separate times, it is nevertheless thought that the bulk of this gneiss was generated at once.

It is difficult to subdivide the gneisses. Heywood (1961) while mapping the Operation Back River region, grouped gneisses under Unit 5 and noted that they vary widely in colour, texture and grain size, and in relative abundance of quartz, plagioclase, orthoclase, biotite, hornblende and garnet. Most are grey or pink, although in many places they are white or red. Most of the rocks are medium grained but fine- and coarse-grained varieties are widespread. Gneissosity and schistosity are moderately well developed, although there are massive varieties. Numerous small areas of schist, paragneiss and amphibolite, probably related to the Prince Albert Group, were not mapped separately. Heywood (1967) later subdivided gneisses in the Operation Wager region to the east. He distinguished three types of gneiss there: layered gneisses, paragneiss, schist and quartzite; granitoid gneisses; and migmatites. Schau and Campbell (1974) tried to subdivide gneisses of the map area by using a technique which clusters rocks with similar internal fabrics and minerals together. The technique yielded four groups in the Hayes River region of which one was assigned to the previously discussed old gneisses of the Brown River Gneiss. The other three were divided into a) gneissic granites or granitic gneisses, b) layered gneisses, and c) paragneisses clearly developed from the Prince Albert Group. In the Hayes River region three blocks, each containing "new" gneiss, were outlined and attempts to distinguish the new gneiss from each block by magnetic and chemical means were moderately successful (Schau, 1975c). That is, detailed geological observations, confirmed by magnetic studies, led to the establishment of different groups of gneisses which, when analyzed, show minor but significant chemical differences (Schau, 1975c). It is important to use geological evidence for separating the groups. Sorting the rocks into numerically homogeneous units would yield different and nongeologically significant answers.

With the exception of the above, the study of the gneisses has not been sufficient to characterize them properly. Only the gneisses near the contact with the Prince Albert Group were traversed.

Kuagnat Gneiss Complex

Distribution and Name

The Kuagnat Gneiss Complex is named after the Inuit name for the Hayes River. These gneisses occur to the northwest of the Kellett Fault (Heywood and Schau, 1978) which constitutes the northwest termination of the Prince Albert Group.

Lithology

Two types of gneissic rocks were differentiated: one in the northwest corner of NTS 56J is porphyritic to porphyroblastic and granodioritic, the other is layered and granitic. The porphyroblastic gneissic granites containing biotite, hornblende, sphene, plagioclase, potash feldspar, and quartz, which have been retrograded to middle and lower metamorphic grades, are characterized by the growth of new minerals such as epidote, chlorite, actinolite, calcite and sphene as well as sericite alteration of feldspars and formation of mortar textures, and presence of shear textures and rotated or strained mineral grains. Magnetite concentrations are irregularly arranged along steep, east-dipping, east-northeast to northeast-striking planes (Schau, 1975c). These gneissic granites (Table 15) differ from the average gneisses in the region in that they are more calcic and less potassic (Eade and Fahrig, 1971). They differ from the gneisses to the southeast of the Kellett Fault zone in that they are more mafic (less SiO_2, more Fe, MgO, CaO, and less K_2O). The Kuagnat Gneisses contain less Ba, Pb, Rb and more V, Ni and Sc, which also reflects their more basic nature (Schau, 1975c).

Structure and Metamorphism

Internal Relations

The porphyroblastic gneiss is vaguely but steeply foliated in easterly to north-northeasterly directions. Oriented feldspars outline foliation. In places, minor folds with northeast-trending axes are paralleled by a magnetic anisotropy lineation in a few analyzed specimens (Schau, 1975c). The layered gneisses near the straight zone are steeply northeast-trending. The contact between the layered gneiss and the porphyroblastic gneissic granite has not been seen, but the latter transgresses the strikes of the former.

External Relations and Metamorphism

The Kellett Fault zone, which forms the southern contact of the Kuagnat gneisses, is apparently a well-recrystallized mylonite. It is marked by platy, vertical, northeast-trending foliation, but the rocks have been retrograded to low and medium grades and do not retain typical mylonite textures.

Age and Correlation

The age of these gneisses is unknown. Their northeast trend suggests that they were deformed in the same late Archean episode as the gneisses to the south and east. The gneisses were emplaced against the already deformed Prince Albert Group by movement of unknown direction on the Kellett Fault zone.

Walker Lake Gneiss Complex

Name and Distribution

The Walker Lake Gneiss Complex outcrops at Walker Lake and appears to be continuous with gneisses which contain Prince Albert Group rock as protolith. The complex is on the western flank of a large metamorphic thermal dome (Schau, 1978). The nature of the contact between this and other gneiss complexes is unknown. The Brown River Gneiss Complex is part of the protolith to the Walker Lake Gneiss Complex. The boundary between the two is arbitrarily drawn along a break on the aeromagnetic maps and is thought to separate considerably modified gneisses, the Walker Lake Gneiss Complex, from the Brown River Gneiss Complex. The Walker Lake Gneiss Complex can be discussed in terms of three northeasterly elongate regions separated by the main Prince Albert belt and an aeromagnetic boundary. The northern portion is north of the main belt; the central portion is between the Prince Albert Group and the southern portion; and the southern portion, south of the aeromagnetic boundary (Fig. 13).

Lithology

The northern region is composed mainly of granitic gneisses and gneissic granites, and granites with few septa of older gneisses of possibly Brown River Gneiss Complex, and of metamorphosed Prince Albert Group rocks. The granitic component is mainly pink to grey, medium grained, locally gneissic biotite granite that resembles the Brown River Gneiss Complex. In places the granite is seriate to porphyroblastic or porphyritic, and contains large microcline crystals and abundant sphene. The rocks are well jointed and

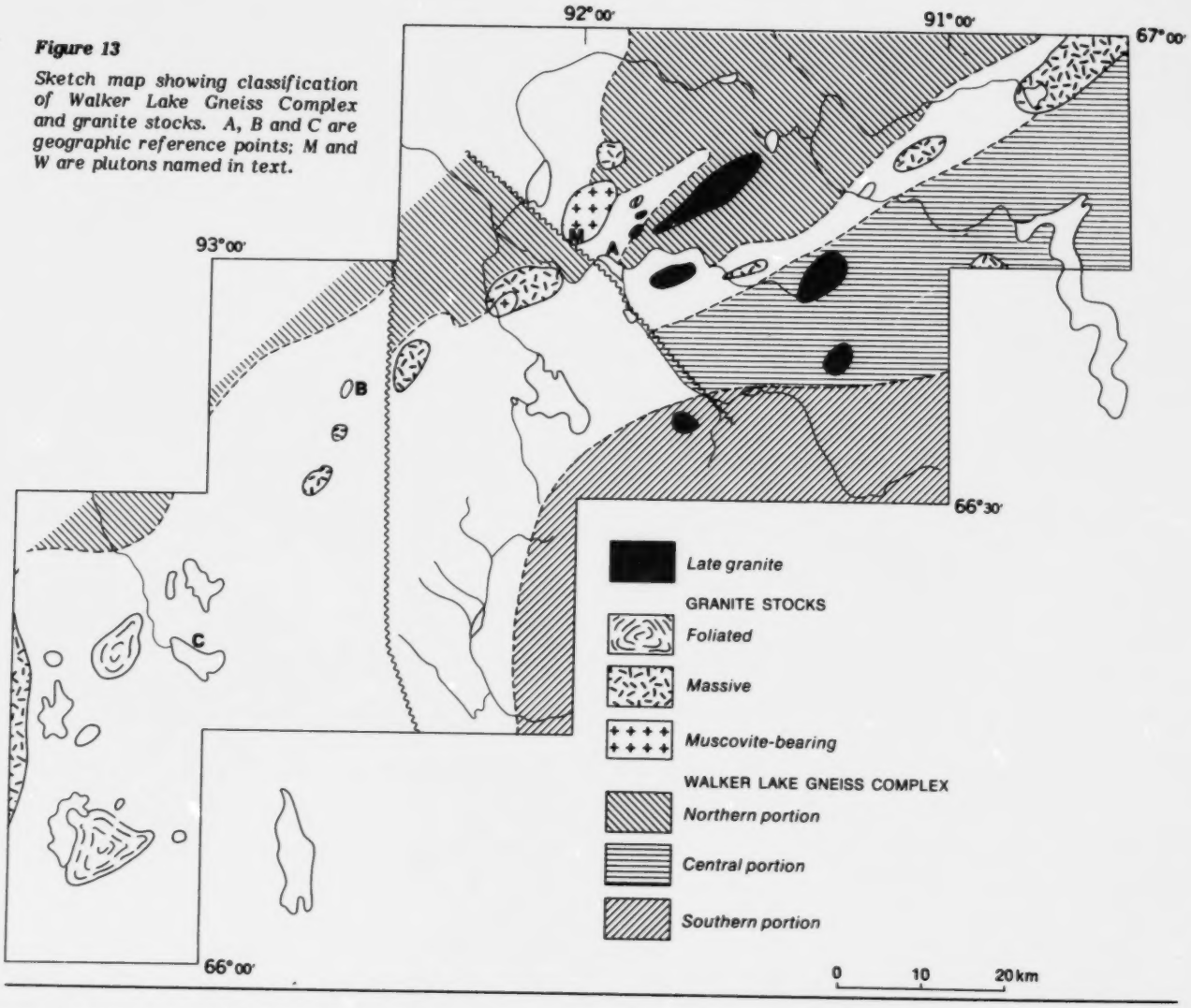


Figure 13

Sketch map showing classification of Walker Lake Gneiss Complex and granite stocks. A, B and C are geographic reference points; M and W are plutons named in text.

pyrite (rarely chalcopyrite or molybdenite) may coat these surfaces. The contact of the granitic component with gneissic rocks generated from the Prince Albert Group is marked by skarns or thin schist septa. Augen gneiss is present in a few places.

In thin section the granitic gneiss is seen to consist of crushed granitic gneiss. Several generations of chlorite and brown pleochroic biotite constitute the mafic silicates. Plagioclase is altered to clay, white mica, and clinozoisite; quartz has been polygonized, and graphic granite textures are present in fractures. Opaques (Ilmenite?) are altered to sphene and fine grained opaques (magnetite?). Zircon, apatite, allanite in epidote, and rare sulphides are accessory minerals. The textures suggest the rock has had a history of crushing, high temperature healing, and later degradation.

Three samples of apparently homogeneous granitic gneiss within 1 m of each other show chemical variability (Table 16, no. 1-3). 16-2 is an example of the more granitic components, whereas 16-1 and 16-3 are more granodioritic in composition. The gneiss is more plagioclasic and more reduced than average gneisses for the region (SiO_2, CaO, Na_2O, Al_2O_3 and FeO/Fe_2O_3 higher, and K_2O, FeO, Fe_2O_3, and TiO_2 lower (Schau, 1975c).

The central region is characterized by biotite-bearing granitoid gneisses, granites and metasedimentary inclusions. It can be divided into two parallel bands – a northern one of low magnetic relief which is mainly granitic gneiss, and a southern one of considerable magnetic relief. This southern gneiss is a hornblende biotite-bearing, medium grained rock cut by finer grained biotite granite sills. Local biotite-rich layers may include discs of felsic material and ptygmatic to intrafolial folds of felsic material. Locally, quartzose iron formation septas form inclusions in the gneiss. In thin section, relatively fresh granitoid gneiss is seen to contain interstitial graphic granite, quartz, oligoclase, and microcline and a small amount of chlorite, epidote, and green biotite. Plagioclase is broken down to clay, white muscovite, and neomorphic, locally poikiloblastic sodic plagioclase. Opaques are altered to sphene, and accessories including zircon, apatite and "allanite"-cored epidote grains. Chemical analyses (no. 4-6, Table 16) show them to be more silicic and sodic than average gneiss in the region.

Near the southern border the gneisses are sheared, locally granulated and show augen textures. The biotite-plagioclase-quartz-gneiss, has been degraded. Quartz is locally granulated, and poikiloblastic oligoclase contains bent

twin lamellae as well as clay degradation products. Brown pleochroic biotite and rare hornblende have been altered to chlorite and green biotite and along some cleavage planes to biotite, epidote, and chlorite; fluorite is scattered in these cleavage planes. Opaques are changed to leucoxene and accessories include zircon, apatite and "allanite" within epidote. Chemical analyses (Table 16, no. 7-9) show them to be more potassic and ferrous than average gneiss (Eade and Fahrig, 1971; Schau, 1975c).

The southern region is characterized by gneissic granite and/or granodiorite and inclusions or septa of almost flat lying biotite-rich layers containing large porphyroblastic K-feldspar crystals. Pink, fluorite- and magnetite-bearing granite occurs near the south boundary of the mapped area. The gneiss of this area contains at least five sets of variable deformed pegmatites.

The felsic portion is granitic textured and consists of quartz, microcline, oligoclase and interstitial graphic granite intergrowths. The plagioclase, in part poikiloblastic, is locally degraded to clay and white mica and a new sodic plagioclase. The rare mafic minerals are bent and consist of olive-coloured amphibole, biotite, and chlorite. The biotite flakes have layers of biotite, epidote and chlorite along cleavage planes. Purple fluorite is associated with alteration minerals and chlorite is locally rutilated. Accessories include zircon, allanite in epidote grains, apatite, sphene, and/or leucoxene. The granitic gneiss is less quartzose and more potassic than that in the central region (no. 10, 11, 12, Table 16). Pegmatites in this region are normal quartzo-feldspathic types but are stained yellow and register about six times background on a scintillometer, but no radioactive mineral has yet been identified.

Structure

Internal Relations

Near the Prince Albert Group the dips of the gneissosity are usually moderate to steep, whereas those of the central part of the gneissic terrane are lower. Relatively flat gneisses in the southern region, contain five variously deformed sets of pegmatite dykes. The central and southern regions have differing magnetic expressions; the southern region is relatively high whereas the central region is generally low. The contact is arbitrarily drawn along this magnetic break, a line roughly parallel to the contact between gneissic and massive granitic rocks of the southern region and the augen gneisses of the central region.

In the northern segment remnants of the Prince Albert Group contain 10 m long pods of ultramafic rocks now altered to chlorite-tremolite-orthopyroxene-olivine-opaque and serpentine or chlorite-tremolite-clinopyroxene and olivine. Multiply deformed isoclinal ultramafic pods and lenses form relicts in these gneisses.

External Relations

The Walker Lake Gneiss Complex has a gradational to intrusive contact with the Prince Albert Group. There is a strong possibility that magnetite-rich granite may contain partly assimilated quartzose iron formation. Septa of resistant Prince Albert Group rock types such as quartzite and iron formation, as well as the large variation in the biotite content of the gneisses, suggests that the Prince Albert Group has been converted to or intimately intruded by Walker Lake gneiss. Some intrusive contacts are marked by local development of hornfels and skarns. The contact between the southern portion of the Walker Lake Gneiss Complex and Brown River Gneiss Complex is arbitrarily defined by a magnetic break which separates generally gneissic granites of the former from layered gneisses of the latter. The Walker Lake gneisses are also cut by some granite stocks and mafic dykes.

Metamorphism and Mode of Origin

The Walker Lake gneisses, originally of amphibolite facies, have been retrograded to greenschist facies, as is shown by the coexistence of chlorite and epidote. Many grains are broken, bent and annealed.

The gneisses were presumably derived from the Brown River Gneiss Complex and the Prince Albert Group.

Age and Correlation

The Walker Lake Gneiss Complex is clearly younger than Prince Albert Group and older than the plutons, mafic dykes and later granite stocks that cut it.

Granitic Rocks

Granite plutons, exposed near or in Prince Albert Group rocks, are divided into foliated or gneissic plutons and massive plutons (Fig. 13).

Foliated or Gneissic Plutons

Western Tonalite Stock

This small stock (W, Fig. 13) is a medium grained gneissic tonalite to porphyroblastic granodiorite which intrudes Prince Albert Group Rocks. It is characterized by steeply dipping, north-northeast-trending foliation and contains a variable abundance of mafic inclusions. Biotite is the most common mafic mineral; hornblende is irregularly distributed. The contact rocks are ultramafic on the north, micaceous metasediments on the east, and quartzites in the south. The western contact rocks are covered. Kyanite is present at the contact and in the metamorphic aureole, as well as in the country rock. This indicates a considerable depth of emplacement. The borders of this pluton, as well as the borders of a similar pluton to the south, are clearly defined on aeromagnetic map 7651G by a change of the low, flat magnetic expression of the intrusions to the high magnetic relief of the bounding, locally iron-rich units of the Prince Albert Group.

Nonfoliated Granitic Rocks

Muscovite Granites

Stocks and pegmatites of very coarse grained muscovite granite are irregularly distributed throughout the region, the largest are found north of point A (Fig. 13) on the Hayes River.

The granite is characterized by abundant coarse grained graphic textured feldspars, muscovite flakes as much as 5 cm in diameter, red garnets 1-2 mm in diameter and rare tourmaline crystals. The large mica grains are locally bent and crushed in zones. Chemical analyses show the granites to be alkalic and peraluminous (Table 17). Crushed zones occur within the stocks, and near the southeast margins, large stoped blocks of mainly Prince Albert Group are abundant. The granite stock intrudes the Prince Albert Group in the south whereas in the northwest it grades into gneisses probably derived in part from the Prince Albert Group. Pegmatites with the same composition cut the Prince Albert Group and related gabbro stocks as well as gneisses of the Walker Lake Gneiss Complex. The rock is apparently intruded by a metagabbro dyke, but contacts are not exposed. The granite is locally recrystallized in crushed zones.

A metamorphic aureole of Prince Albert Group rocks is developed around the muscovite granite. Biotite content in chlorite-tremolite-carbonate-opaque-talc rock increases near the contact where it is a porphyroblastic chlorite-biotite-opaque-talc-tourmaline rock. Amphibolites in the aureole consist of quartz-hornblende-sphene-epidote-calcite and quartz-phlogopite-diopside-epidote-calcite interbedded with

chlorite-phlogopite-tremolite-opaque units. Elsewhere, the ultramafic unit has been altered to tremolite-opaque-carbonate, phlogopite-hornblende-diopside-sphene-garnet-clinozoisite-diopside-garnet-carbonate rock and diopside-enstatite-vein serpentine-sphene-clinozoisite skarns in the aureole. Ultramafic schists in the aureoles contain serpentine pseudomorphs of porphyroblastic olivines which are anastomosing aggregates as much as a centimetre in diameter. Gabbro textures in the aureole are obliterated; only granoblastic aggregates of plagioclase-hornblende-sphene-epidote or plagioclase-quartz-hornblende-clinozoisite-muscovite remain.

The physical environment of emplacement of these stocks was epizonal to mesozonal. The depth of emplacement would have been about 3.5 kb*, the minimum water pressure at which muscovite could develop in a peraluminous granitic melt. The coarse textures of the granite as well as large tourmaline crystals (up to 15 cm long) in the metamorphic aureole suggest that crystallization proceeded in an aqueous environment. The presence of small red garnets in the granite suggests that the magma was derived from the melting of garnetiferous, muscovite-rich sediments such as are present in the Prince Albert Group. The metamorphic grade of the country rock is somewhat lower than that required for minimum melting so presumably the magma has risen from its zone of melting.

The age of the stocks and dykes is uncertain but they were intruded after some deformation of the Prince Albert Group, and prior to local crushing and faulting and emplacement of mid-Aphebian metagrabbro dykes. It is thought to be related to gneiss-making events marking the end of the Archean in this region. Radiometric dating by K-Ar methods yields contradictory results (Table 12). Muscovites from the granite is 1735 Ma, tourmaline from the contact is 2342 Ma, biotite from contact returns a 1683 Ma date. Hornblende from a mafic dyke which cuts the granite pluton has a K-Ar date of 1891 Ma.

Massive Granitic Rocks

Massive, medium grained granodioritic stocks and plutons, present mainly in the western part of the region, intrude the Prince Albert Group. The western edge of the mapped area is at the contact with a large pinkish to white granite to granodiorite pluton. Two small stocks of massive granodiorite to tonalite cut sheared gabbro and folded Prince Albert Group south of lake B (Fig. 13). Small white to pink biotite granite or granodiorite stocks are found north of point A (Fig. 13) near the muscovite plutons. They appear relatively fresh although the biotite is degraded to biotite-chlorite-epidote and feldspars are locally bent or altered. They differ from the muscovite granites mainly in being more sodic (Table 17, no. 3) and probably represent a different but synorogenic magmatic episode. Other similar, small to massive granitic stocks are found along the outcrop belt of the Prince Albert Group in the eastern region.

A white weathering, light grey, medium grained, seriate to porphyritic biotite-bearing quartz monzonite stock exposed in map area 56K/3 becomes finer grained near the margins. In one place at the contact feldspars are altered to clay, and arsenopyrite is abundant. Elongate xenoliths of foliated country rock in massive quartz monzonites, and the decrease in grain size towards the margin suggest that the stock was emplaced in a cool environment and confirms that the pluton was post-metamorphic.

Metadiabase Dykes

Two metamorphosed diabase dykes present east of the Hayes River (66°46.2'N, 91°21.6'W and 66°43.8'N, 91°49.2'W) are as much as 50 m wide and are irregularly exposed for about 20 km. Parts of another dyke are found in the north-south fault system and a fourth is present northwest of Laughland Lake at (66°18.6'N, 93°02.4'W).

The dykes are dark green with good diabasic texture. Chilled contacts are locally preserved b[illegible] most contacts are sheared. Felsic veins that cut the contact are folded. The metamorphic nature of the dykes is seen in thin section. Small, blue-green amphibole needles have grown within the relic, and generally recrystallized, plagioclase crystals and have replaced the pyroxenes. Chemical analysis of two dykes (Table 18) reveals that they are more basic and show a lower ferric ferrous ratio than average diabase, but both are classified as tholeiitic basalt using Irvine and Baragar's scheme (1971).

The dykes which transect all layered units in the region were intruded into rock that was sufficiently brittle to yield angular inclusions. Subsequent movement along the borders is indicated by extensive schistosity and local crinkling. In many outcrops the dykes are folded and faulted. Near point A north of Hayes River a metagabbro dyke is sheared and contains zones of protomylonite. These zones, folded about vertical axes with a dextral sense of movement, contain potash feldspar porphyroblasts or veins of quartz and feldspar. Later, small plutons east of point A appear to be responsible for the recrystallization and local felsic veining in the dyke in that region.

A whole-rock K-Ar determination gave a mid-Proterozoic date (1613 Ma, Table 12) but a K-Ar determination on a hornblende from the dyke gave a K-Ar age of 1891 Ma (Table 12). The latter could date the time of emplacement of the younger pluton, which is in part responsible for its recrystallization, or date the time of emplacement of the dyke, or represent a composite date. An attempt was made to date the dyke near Hayes River by paleomagnetic methods, but no stable magnetic orientation could be isolated from the metagabbro. Recrystallization of the opaque oxides into sphene, ilmenite and iron-bearing amphibole destroyed the thermal remanent component. X-ray diffraction studies and Curie point determinations indicate that the opaques consist of a small amount of magnetite and somewhat more magnetic pyrrhotite. The latter mineral is responsible for the extremely unstable character of the weak remanent component. These data again confirm that the recrystallization of the metagabbro was a middle or low grade phenomenon of considerable efficiency.

Late Granitic Plutons

Northeast-trending generally massive late granitic plutons are present in the vicinity of the Hayes River fault and one of the metadiabase dykes near point A (Fig. 13).

Typical late granite plutons are reddish weathering, medium grained, equigranular to seriate rocks with variable amounts of biotite, tourmaline and amphibole. Thin sections show well zoned plagioclase and orthoclase in graphic granite intergrowths. The mafic minerals include altered green biotite, rare chlorite, blue-green amphibole and accessory carbonate, tourmaline, sphene, zircon, epidote, apatite and magnetite. The unit contains phases that are best described as alkalic granite (Table 19).

*1 kb = 1 x 10^5 kP

Xenoliths of Walker Lake Gneiss grade into gneissic portions of plutons. Pegmatites and vein material from plutons cut metadiabases. A metakomatiitic schist inclusion within the Walker Lake Gneiss Complex is remetamorphosed in the metamorphic aureole associated with these late granites. The new mineral assemblages are: chlorite-talc-opaques; chlorite-phlogopite-talc-hematite; chlorite-phlogopite-olivine-serpentine-talc; and phlogopite-talc-opaques. A large variation in potash content is evident over distances of a metre (Schau, 1975b).

The source of the plutons is not known but as the composition is near minimum melting composition, presumably the plutons are anatexites from deeper in the crust emplaced in zones of tension associated with the folding that produced southeast plunges and possibly some faulting.

The unit is the last felsic magmatic event in the region. A K-Ar date on a tourmaline from a pluton yielded 1800 Ma (Table 12). A Rb-Sr isochron on biotite-bearing rocks from the ultramafic pod in the metamorphic aureole indicates that Rb-Sr isotopes were last equilibrated at 1679 ± 26 Ma. The initial ratio was .8260 ± .0697 (Schau, 1980), which indicates that the equilibration affected a previously rubidium-rich environment.

Mackenzie Dykes

One brown weathering northwest-trending dyke 10 m wide outcrops southwest of A (Fig. 1). To the northwest, the unit has positive aeromagnetic expression whereas to the southeast it has a negative aeromagnetic pattern. The dyke transects the Brown River Gneiss Complex, Prince Albert Group, Kuagnat Gneiss Complex and possibly the Walker Lake Gneiss Complex. It is considered Mackenzie because its trend is the same as that of the Mackenzie dyke swarm.

MODE OF ORIGIN OF PRINCE ALBERT GROUP

Introduction

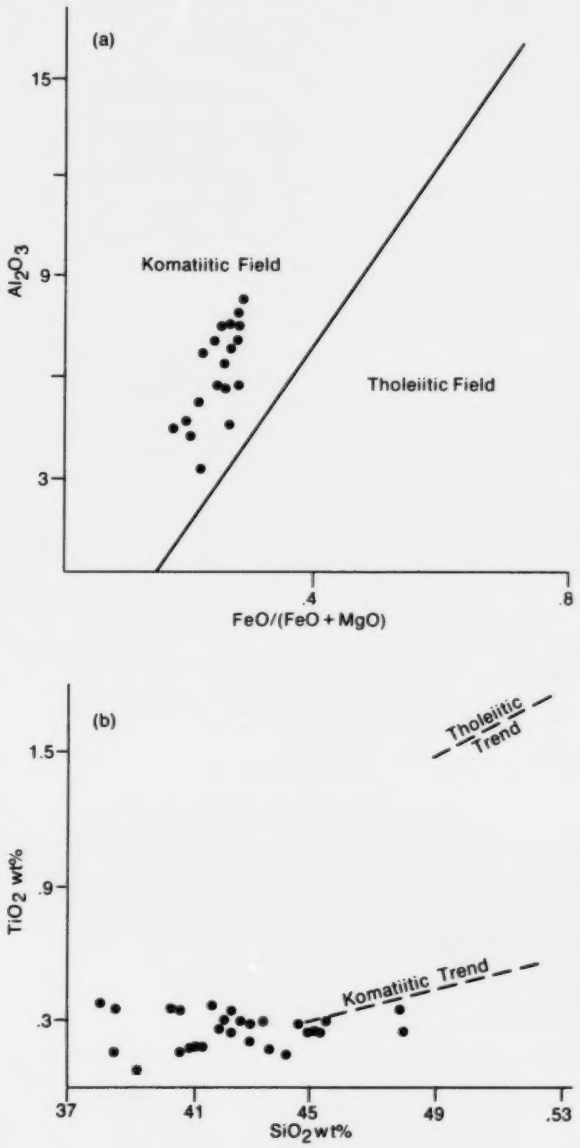
The Prince Albert Group rock association is unusual for the Archean in that rocks with extreme compositions, such as quartzite, iron formation, pelites and ultramafic lava flows, are interlayered. Since relict sedimentary features are few, considerable reliance is placed on interpretation of chemical analyses to determine the origin of the Prince Albert Group.

Metavolcanic Rocks

The metamorphosed ultramafic rocks are thought to have been extrusive hypabyssal ultramafic melts emplaced as an integral part of the Prince Albert Group (Eckstrand, 1975b; Schau, 1975b, 1977). They contain spinifex textures, polyhedral jointing, and well developed, 1 m thick, alternating, green and chocolate brown weathering layering. The unusual chemistry of these lavas (Tables 5 and 6) is shared with other ultramafic lavas called komatiites, a term introduced by Viljoen and Viljoen (1969a) for peridotitic and related mafic lavas of the Barberton Mountain area of South Africa.

The latest definition of komatiite and komatiite series is: "...(a) It comprises non-cumulate rocks ranging in composition from peridotite (approximately 30% MgO, 44% SiO_2) to basalt (8% MgO, 52% SiO_2) or andesite (12% MgO, 56% SiO_2), and cumulate rocks ranging from peridotite (up to 40% Mgo) to mafic gabbro (approximately 12% MgO). The compositions of the non-cumulate rocks closely resemble the compositions of the silicate liquids from which they form. (b) The series contains lavas that exhibit unusual textures and volcanic structures, such as spinifex texture and polyhedral jointing. (c) All members of the series have low total FeO/(FeO+MgO) ratios, low TiO_2 contents, and high MgO, NiO_2, Cr_2O_3 content, and some, but not all, have high CaO/Al_2O_3 ratios..." (Arndt et al., 1977).

Inspection of Tables 5 and 6 and Figures 14a,b and 15 shows that the majority of the komatiitic rocks are peridotitic within the map area. Brooks and Hart (1974) have stressed that peridotites fall in the field of peridotitic komatiites as they define them so that without textural criteria the chemical assignment is not valid. In the map area, textural criteria such as polyhedral jointing or spinifex textures (Fig. 5) are rarely present, in part because deformation has modified the primary fabrics.



(a) Shows clustering of points in komatiitic field (after Schau, 1977).
(b) Shows that titania content is related to komatiitic trend of Arndt et al., rather than tholeiitic trend of same authors.

Figure 14. *Metakomatiitic rocks plotted on characteristic diagrams (Arndt et al., 1977).*

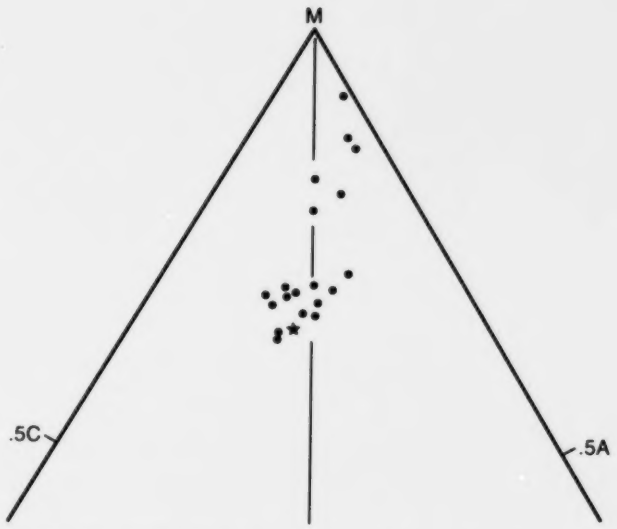
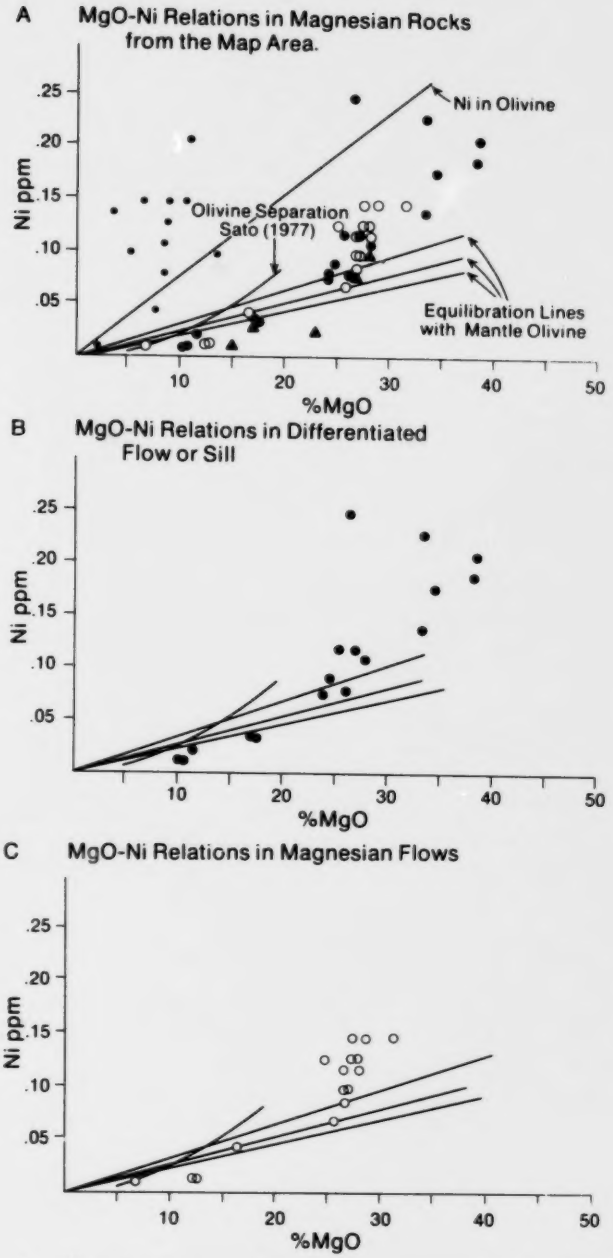


Figure 15. *ACM Diagram (Al_2O_3, CaO, MgO) of meta-komatiitic rocks (Brooks and Hart, 1975). Shows the importance of olivine fractionation. The star is the most anhydrous specimen. Modified after Schau (1977).*

Some of the units may be sills or thick, differentiated flows with olivine-rich cumulate layers, as relict cumulate textures are present in one locality. There the sill or flow was near surface because irregular fragments, now composed of serpentine having shapes of strained vesicular scoria, are present in carbonate layers, suggesting that some ultramafic clastic fragments were locally derived.

Sato (1977) suggested that the primary basaltic magma, formed from a 25 per cent partial melt of peridotite, containing about .030 to .050 weight/per cent nickel oxide. Mantle olivine contains about 0.45 weight/per cent nickel oxide, hence olivine concentrates nickel oxide during crystallization and this liquid is rapidly depleted. Estimates of the extent of fractionation can be determined using Sato's diagram for lavas like those of Hawaii (Fig. 16a). Should the lavas be formed by partial melting of a greater proportion of mantle, it will yield a larger nickel oxide tenor for the initial magmas. The nickel magnesium oxide patterns will be similar except that they will be displaced along the line linking the magnesia and nickel in partial melts derived from the mantle. Such a plot (Fig. 16b) suggests that moderate fractionation took place, yielding a liquid with upwards of 20 per cent cumulate olivine and other liquids with the appropriate depleted values from an initial liquid of about 50 per cent melt mantle in one area. The most anhydrous sample which has been previously used as an approximation of the best composition of komatiite in previous publications (Schau, 1975b) using this plot, would contain about 5 to 10 per cent cumulate olivine. The averages published by Arndt et al. (1977) are all in the nickel-depleted part of the curve, suggesting that considerable olivine has already been extracted from the komatiites near Munro Township, Ontario.

In another area olivine appears to have been enriched (above guidelines (Fig. 16c)) or depleted (below guidelines (Fig. 16c)). There is thus chemical evidence for crystal fractionation of the magma in a sill. In both regions the melt is that derived from about 50 to 60 per cent partial melting of mantle material (such as the mantle material used by Sato, 1977). Thus, although olivine enrichment can be shown to be important, the melt from which the olivine is



A. All rocks in area. Small dots - weathered and leached komatiitic debris, larger symbols form komatiitic units in map area. Line from origin to Ni in olivine is maximum igneous ratio attainable. Lines labelled equilibration, lines with mantle olivine taken from Sato (1977). Curved line shows path taken by melts as olivine separates from a source melt with about 11% MgO. See text for further explanation.

B. Same as A but from a sill or differentiated flow near Hayes River. Note high nickel and magnesia values, suggesting large amounts of olivine have differentiated from a source with about 20-27% MgO.

C. As above, except these are samples from flows near A. They appear to have separated from a source with about 26% MgO.

Figure 16. *Metakomatiite rocks displayed on nickel oxide vs magnesia diagram after Sato, 1977.*

Figure 17

Photograph of large scale crossbeds in quartzite in the Prince Albert Group (Schau, 1977). GSC 178411

crystallized was very magnesian at the outset (about 28 per cent magnesia). The presence of dykes with similar compositions is also beyond doubt, so that although the area has been intensely deformed, it is probable that parts of the entire plumbing system of a komatiitic volcano are present in the map area. The region where a volcanic centre is most likely to have been situated is near the headwaters of Brown River. A considerable volume of doubly folded and complexly faulted serpentinized ultramafic rocks is present there, including well layered regions locally containing units of polygonal jointing and spinifex textures. The shape of the complex, and the internal relations have not been deduced. Less extensive accumulations, some clearly intrusive, others probably extrusive, are present northwest of Laughland Lake and west of Walker Lake.

The tectonic meaning of the komatiitic volcanic suite is not clear. Peridotitic komatiites are mainly present in Archean rocks (Brooks and Hart, 1974) but are also known in Proterozoic rocks from Canada (Arndt, et al., 1977; Schwarz and Fujiwara, 1977). Basaltic komatiites are known from the Archean to Lower Paleozoic age (Viljoen and Viljoen, 1969b; Arndt, et al., 1977; Gale, 1973). The Mesozoic Karoo Group of McIver and Lenthall (1974) has been considered a form of komatiite by those authors, and Clark (1970) considered the Tertiary picritic basalts of Baffin Island and Western Greenland as examples of komatiites. Upper Cretaceous to Paleocene ultrabasic volcanics from the East Kamchatka Range contain structures characteristic of extrusives and a komatiitic chemistry (Markovskiy and Landa, 1977). Paleogene komatiites have been reported from Gorgona Island off the Pacific shore of Colombia (Gansser et al., 1979). Recent lavas from the New Georgia Group, part of the British Solomon Islands volcanic arc, include peridotitic "komatiites", picrites and ankaramites, as well as olivine basalts and hornblende-bearing basaltic andesites. Some of the analyses from this region contain the appropriate chemistry (Carmichael et al., 1974) but the requisite textures have not yet been described. Thus, the more refractory members of the series appear as lavas mainly during the early half of the earth's history, but the less refractory members may have persisted for a longer time span. Komatiites were originally thought to be part of the oldest crust (Viljoen and Viljoen, 1969a,b) but since then considerable work has demonstrated that they appear in virtually every tectonic setting, ranging from deposition environments in which well differentiated sedimentary rocks have been deposited (Bickle, et al., 1975; Schau, 1977) to island arcs (Brooks and Hart, 1974) and postulated meteorite craters (Green, 1972). Komatiite has apparently been deposited on all types of crust; hence they have no tectonic significance.

Temperature estimates of the extruding ultramafic magma cluster about 1600°C (Green, 1972). This high temperature estimate, deduced from the mineralogy and confirmed in laboratory estimates (Green et al., 1975), suggests a provenance deep in the mantle. McIver (1975) has studied a set of (komatiitic) ultramafic lavas from South Africa (Onverwacht, Ventersdorp, and Karoo groups) and concluded from their compositions that they were derived from a lava column in equilibrium with mantle at a depth of about 90 km. A crust capable of brittle fractures seems to have been a necessity to maintain channelways for this deep-seated lava (Markovskiy and Landa, 1977), so that it could be emplaced at the surface before olivine crystals started to settle from the magma.

Biotite-bearing ultramafic rocks intimately associated or interlayered with komatiites are not chemically classified as komatiites (Table 7). These rocks would classify as alkalic-picrite basalts (Irvine and Baragar, 1971). However, the continuous variation from normal ultramafic rocks to these biotite-rich ultramafic rocks has been confirmed by Eckstrand (1975b). Whether the rocks are locally or variably biotitized (cf. Waters, 1955) or are peculiar ultramafic lavas, is not clear. Highly alkalic ultramafic lavas are characterized by low silica content and high potash phosphate-titania-strontium-barium and zirconium (Higazy, 1954). The rocks in the area mapped are poorer in titania, phosphate, sulphur, strontium, barium and zirconium by over an order of magnitude. Therefore the biotite ultramafics do not have the minor element composition for an alkalic ultramafic lava. They do, however, contain chrome, nickel and cobalt typical of a normal komatiitic rock. This would suggest that watery solutions associated with weathering, or less probably diagenesis, or low temperature metamorphism, degraded some ultramafic minerals which then fixed the contained potassium ions in a sheet mineral.

Quartzites

The metaquartzites of the area yield little evidence as to their origin. Primary sedimentary structures are rare.

Figure 18

Photograph of crossbeds in quartzites of the Prince Albert Group (Schau, 1977). GSC 178407

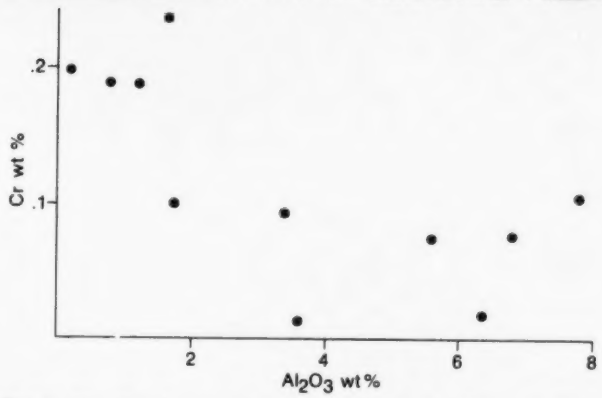


Figure 19. *Alumina vs chrome in metaquartzites. Chrome tenor is high and the crude inverse relationship may indicate that chrome (as chromite?) was accumulated where alumina (as clay) was winnowed.*

Near Laughland Lake crossbeds more than 10 m high and 30 m long were observed (Fig. 17, Schau, 1977). Northeast of Walker Lake the crossbeds are less than 0.5 m high (Fig. 18, Schau, 1977). As crossbedding occurs in sediments whose grain size usually exceeds about 0.5 mm in fluvial deposits laid down by unidirectional traction currents (Selley, 1976, p. 177) the quartzites are interpreted to be clastic rocks. Large crossbeds suggest but do not prove an eolian origin (Walker and Middleton, 1977). Selley (1976) in discussing the usefulness of the concept of maturity in classifying sandstones noted that the maturation of a sandstone takes place physically by the processes of sorting and winnowing with resulting textural changes and chemically by destruction or alteration of unstable minerals. Where isochemical metamorphism is assured, chemical composition will remain constant but textural alterations will take place. Thus, chemical analysis can yield data about the provenance and the chemical maturity of the sediments (Garrels and MacKenzie, 1971). If mica is assumed to represent the matrix in the original rock and the feldspars are unchanged, the mode of micaceous minerals would provide an estimate of the physical maturity of the rock. This estimate would be biased because during diagenesis feldspars change to clay minerals. Other uncertainties would include the amount of diagenetic cement such as silica and carbonate added to the rock. These effects would be very difficult to discern in rocks which have been metamorphosed in middle grades.

Analyzed quartzites (Table 8; Fig. 19) are very siliceous and locally aluminous and chromian in nature. They are in general similar to modern quartz sandstones. The normative sedimentary mode (Garrels and MacKenzie, 1971) has been calculated and these are plotted in Figure 20 (Selley, 1976). Half of the Prince Albert Group specimens plotted are more quartzose than Garrels and MacKenzie's (1971) example and they may appropriately be classified as quartzites. Some structures such as small crossbeds, as well as rapid facies change along strike from quartzite to mica-shale or pelite may indicate a waterlain origin; other structures, such as the giant crossbeds may be of eolian origin.

Adams and Weaver (1958) have studied the uranium-thorium concentrations of continental sandstones and concluded that: 1) distribution of uranium in sedimentary rocks is largely determined by oxidation and leaching during weathering, whereas immobile thorium is left behind in resistates or absorbed on clays and hydrolyzates; 2) the products of a high thorium-uranium ratio environment (more than 7) are materials that are thoroughly weathered, oxidized and leached; 3) uranium and low thorium-uranium ratios tend to be concentrated in regions where reduction has taken place; 4) primary igneous rocks have thorium to uranium ratios about 3 to 4 and contain about 10 to 15 ppm thorium. The uranium vs. thorium content of analyzed quartzites (Fig. 21) suggests that these rocks are not enriched in uranium, as are so many of the later quartzites in the District of Keewatin. Secondly, the relative thorium and uranium contents suggest that continental environments of weathering, oxidation and leaching, have affected these rocks. The highest uranium content (2.5 ppm) is associated with the highest zirconium tenor (830 ppm) so that any uranium is probably carried in relatively scarce zircons. Thorium might be associated with monazite, however no cerium or yttrium were detected and lanthanum was present but below 50 ppm detection limit of the optical emission spectroscopic method used. In thin section, hematite, scarce allanite and other accessories are rarely present.

These observations suggest that quartzite was a continental type in that it had undergone weathering, oxidation and leaching.

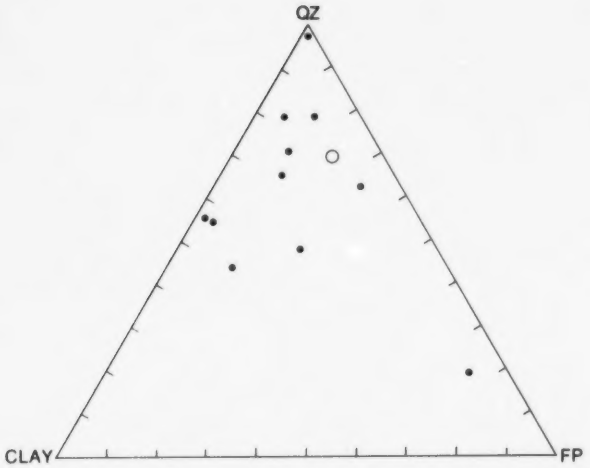


***Figure 20**. Plot of sedimentary "modes" in quartzose rocks of Prince Albert Group (after Selley, 1976). The modes are derived from sedimentary norms calculated using Garrels and MacKenzie (1971). Open circle is average quartz sandstone of Garrels and MacKenzie (1971).*

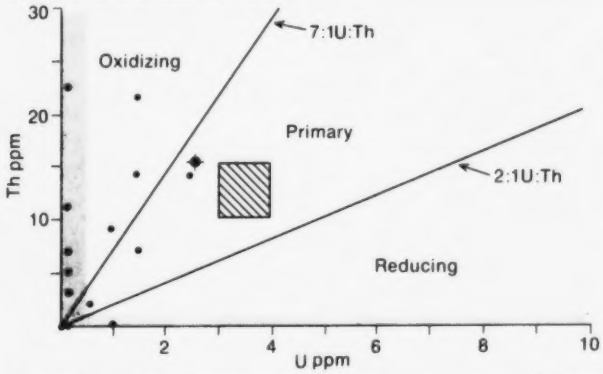


***Figure 21**. Plot of uranium vs thorium in quartzites of Prince Albert Group. Grey tones – analytical limits. Square box incorporates average igneous values (Adams and Weaver, 1958). Lines with specified ratios separate oxidizing from undisturbed and reducing nature of the depositional environment.*

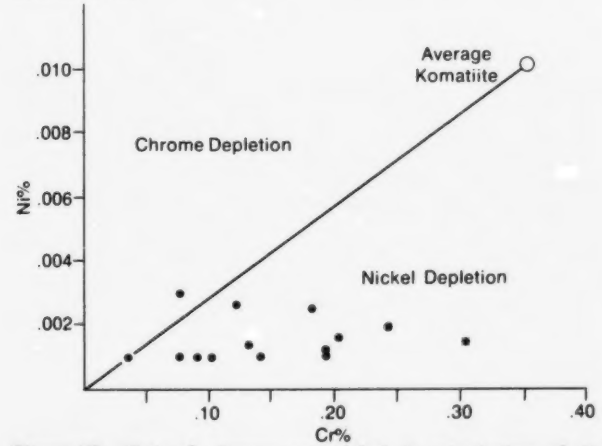


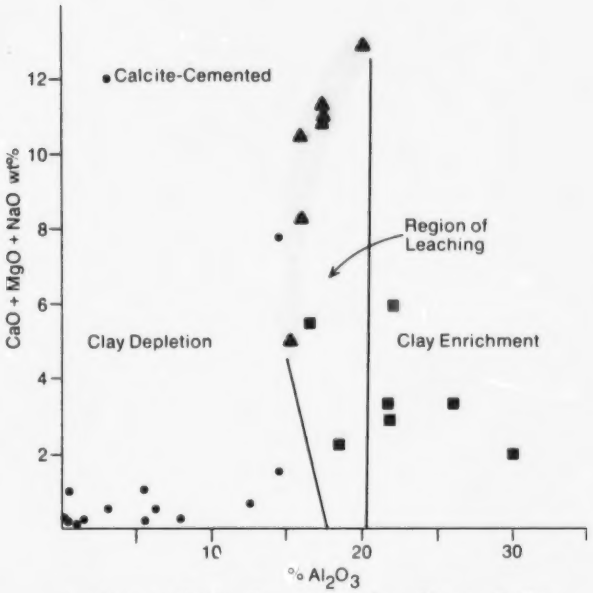
***Figure 22**. Plot of chrome vs nickel in quartzites of the Prince Albert Group. The open circle is average komatiite. It is apparent that chrome is enriched with respect to nickel.*

These quartzites, which have a high chrome content, contain chromian muscovite as well as colourless muscovite and possibly rare chromite grains. In igneous rocks chromium is usually associated with nickel, but the nickel content in the quartzites is near the minimum detection limit. The chrome may have occurred as an oxide in komatiites, whereas nickel was present as a sulphide or both were present in the magnesian silicates. Other potential source rocks for chrome and nickel contain much lower concentrations. Acid solutions derived from the breakdown of nickel and iron sulphides would enhance leaching of the magnesian silicates, whereas the chromite would remain intact. Thus, the separation of chrome and nickel would result. The nickel and chrome tied up in silicate solid solutions would be dissolved by the solutions derived in part from the acids mentioned above, and in part from the acids supplied in normal rain. Loughnan (1969) has noted that chrome becomes an integral part of some clays in deeply weathered rocks. The pH at which an amphoteric hydroxide is least soluble and least likely to have a surface charge is called the isoelectric point of the solid (IEPs). The IEPs of $Cr(OH)_3$ is 7.1 and $Ni(OH)_2$ is 11.3 (Stumm and Morgan, 1970). Thus, Cr^{+++} and Ni^{++} behave differently in solutions, the chrome being more likely to be precipitated or coagulated under neutral pH than the nickel, which would under these conditions be absorbed into strongly charged negative surfaces such as colloidal silica. The net result is again a separation of chrome and nickel in the weathering environment. These two explanations could account for the observed differentiation of chrome and nickel in the quartzites. Cobalt would act in much the same way as nickel and the low values reported for the quartzites also suggest that this element has been, if it were ever present, leached from the rocks.

Leaching could also have affected the Brown River Gneiss Complex (which locally occurs as pebbles in basal sediments of Prince Albert Group). The mobile elements of weathering (Ca, Mg, Na) are plotted (Fig. 23) against the most immobile element (Al) for samples of quartzites, pelites and assortment of analyzed old gneiss from the map area. If the gneisses were leached and no sorting or separation had taken place, samples would lie in the enclosed region of Figure 23. However, sorting, probably by differential transportation, separated the clays from the quartz to produce pelites and quartzite. Unfortunately, the structures and textures necessary to demonstrate the method of transportation are not preserved. Local rapid facies changes from quartzite to sericite schist over a few tens of metres suggest that the environment of deposition was one of local transportation and separation. A river channel, dune, or an offshore bar would be a better model than a basal sandstone sheet.

In summary, then, rare sedimentary structures suggest that the quartzites were clastic. There is textural and chemical evidence of local separation and transportation of weathered minerals. Trace element data suggest that the source rocks and/or the deposited rocks have been leached in an oxidizing environment. The low iron aluminous pelites suggest that a gneissic terrane may have been part of the provenance of these rocks. The high chrome contents of quartzite suggest that komatiites contributed chromite or chrome-enriched clays to the quartzites.

The association of quartzites and ultramafic lenses also occurs at Outokumpu in Finland (Aarto, 1976). Trace elements of quartzites from this region make them distinguishable from ordinary quartzites on the basis of their very high cobalt and nickel contents; the Prince Albert Group differs in that cobalt and nickel are below spectrographic detection limits. Bickle et al. (1975) have described Archean komatiites, quartzites and dolomitized stromatolites unconformably overlying a gneissic basement. There the quartzites are clastic, the komatiites shallow water, and the entire suite, ensialic, similar to the Prince Albert Group association.



grey tones and triangles original gneissic variation
squares – phyllites and pelites
dots – meta-arenites.

Figure 23. *Plot of labile oxides of metasedimentary rocks of Prince Albert Group compared to basement source gneisses.*

An Archean example of amphibolites, amphibolitic tuff, metatuffs, quartz-siltites, and quartzites has been described by Friedman (1959) at Samreid Lake (Superior Structural Province, Canada). He suggested that the metamorphosed amphibolites, quartz-siltites and quartzites derived from shale, argillaceous siltstone and sandstone, contained a stable assemblage consisting of chlorite, biotite, garnet, muscovite and quartz, whereas a fine grained quartz, pyrite, pyrrhotite, magnetite layer is recrystallized chert. The environment of deposition is assumed to be on the eugeosynclinal slope zone of a shallow sea in an area of submarine volcanic activity, similar to that occurring near Volcano, Italy today.

Iron Formation

Layered iron formations consists of alternating quartz and iron mineral layers. Typical samples have been chemically analyzed (Table 9) and are similar to other suites of iron formations (James, 1966).

The origin of the layered iron formations of the Prince Albert Group can in part be deduced by considering their chemical makeup. The units were probably formed from solution rather than by mechanical accumulation. The trace element content of the analyzed Prince Albert layered iron formation is not chrome-rich like that of the clastic quartzites, and the magnetite does not contain trace element concentrations common to igneous rocks. The vanadium content of iron formation containing 50 per cent magnetite is less than 20 ppm, whereas a similar amount of magnetite derived from igneous rocks would contain about 500 ppm vanadium. Titanium ranges from 0.02 to 0.22 per cent in the Prince Albert iron formations whereas titanium values approach 3.5 per cent in recent black sand placers (Untung and Hanna, 1975). Therefore the Prince Albert iron formation is not composed of detrital magnetite derived from metamorphic or sedimentary terranes. There is a possibility that ultramafic rocks were deuterically serpentinized prior to weathering and that the magnetite thus liberated was released as a sediment and accumulated to form magnetite layers in the iron formation. This magnetite (since it is a chemical precipitate within the serpentine) would be difficult to distinguish from chemically precipitated iron oxides in the sedimentary environment. However, the layered iron formations are not enriched in chrome, and chrome from the komatiite would presumably have moved with the magnetite, were it of such a detrital origin.

A chemical model involving coprecipitation or cofloculation of hydrous iron oxides and silica colloid from solutions derived from weathering probably explains the formation of the layered iron formations of the Prince Albert Group. A model of "banded iron formations" has been suggested by Hough (1958) in which the alternate deposition in lake waters of iron silicate or oxide and silica is favoured by periodic appearance of alkaline solutions such as those in playa lakes (Garrels and MacKenzie, 1967). It is possible that a variant of this model applies in the map area. It would explain the rare but scattered appearance of blue (sodic?) amphiboles in the iron formations.

An alternate model deriving the iron and silica precipitates from solutions stemming from ocean crust sources is thought less probable since the chemical characteristics of the layered iron formations of the Prince Albert Group are not similar to those of oceanic precipitates. Suboceanic hydrothermal iron layers precipitated by hydrothermal springs from Eocene to Miocene beds in the oceanic crust between Iceland and Jan Mayen Island has been studied by Emel'yanov et al. (1977). They found that sediments had an iron and manganese to titanium ratio greater than 25, which was interpreted as an indication of an endogenic source for the solution. This ratio is shared by the iron formations of the Laughland and Walker lakes map area. In the north Atlantic precipitates the chrome tenor ranges from 31 to 65 ppm, and nickel ranges from 107 to 624 ppm. By contrast, in the map area, both elements are low in the layered iron formations (chrome = 49 to 99 ppm, nickel, 46 to 75 ppm). The difference in behaviour of the chrome and nickel suggests that hydrothermal solutions, associated with an oceanic volcanic ridge are not the source for the iron. Bonati et al. (1976) have proposed a volcanogenic model in which metalliferous sedimentary rocks and metal sulphide mineralizations originated as a result of mobilization of metals from basalts during circulation of thermal waters in a basic crust close to a spreading centre. They further characterized the chemistry of this type of iron formation by plotting it on a triangular diagram whose apices are Fe, Mn, and (Ni+Co+Cu)x10 (Fig. 24). The samples from the Laughland and Walker lakes map area differ from deposits classified as hydrogeneous that characterize the present ocean floor, and instead lie nearer but deviate significantly from the hydrothermal deposits leached from basalts at Thera, Stromboli and the Red Sea deeps. It is concluded that the layered iron formations are not suboceanic in origin.

It is concluded that the layered silicate-quartz, and magnetite formations were probably formed by precipitation or flocculation from solutions. The exact source and depositional environment cannot be deduced from the chemistry, but two are proposed. One involves solution from weathering rocks and subsequent deposition in ephemeral lake bottoms, the other as a volcanic effluent from a metamorphically leached basic crust in an oceanic environment and subsequent deposition as oceanic sediment. The first model is favoured.

Greenschists and Phyllites: Weathering Products of Komatiites

Layered greenschists and amphibolites suggest that they are sediments. Their chemical analyses showed that some (Table 9) contained more than 15 per cent total iron, the lower limit for sedimentary iron formations (James, 1966).

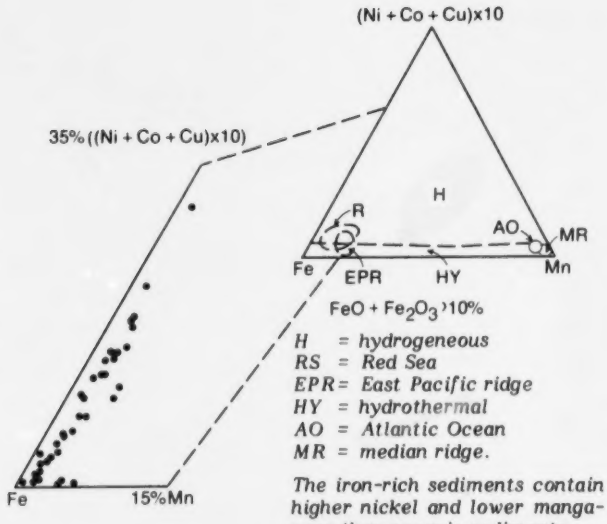


***Figure 24**. Plot of transition elements in iron-rich metasedimentary rocks of Prince Albert Group compared to types differentiated by Bonatti et al. (1976).*

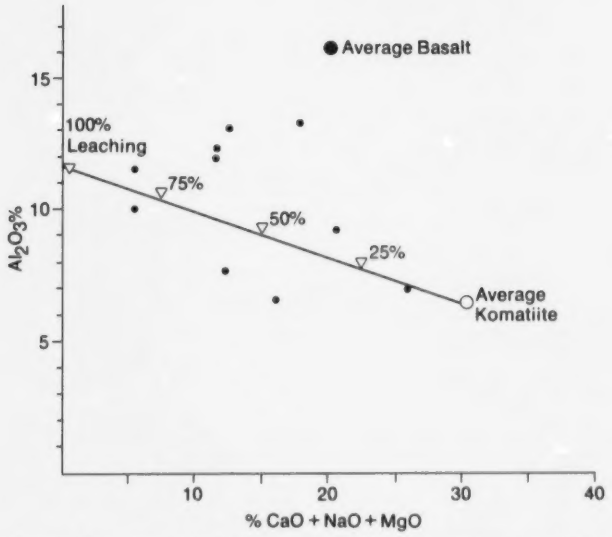


***Figure 25**. Plot showing progressive removal of mobile cations from komatiites to generate iron + aluminum-rich sediments of Prince Albert Group. Open circle is average komatiite. Percentages indicate completeness of leaching. Solid circle is basalt, indicating that leaching of basalt is not important.*

The majority are aluminous and contain relatively large amounts of chrome, nickel and vanadium, and variable amounts of manganese, elements not usually associated with iron formations. These sediments are interbedded with quartzites, carbonates, pelites and komatiites; the latter are closely associated with the layered iron formations.

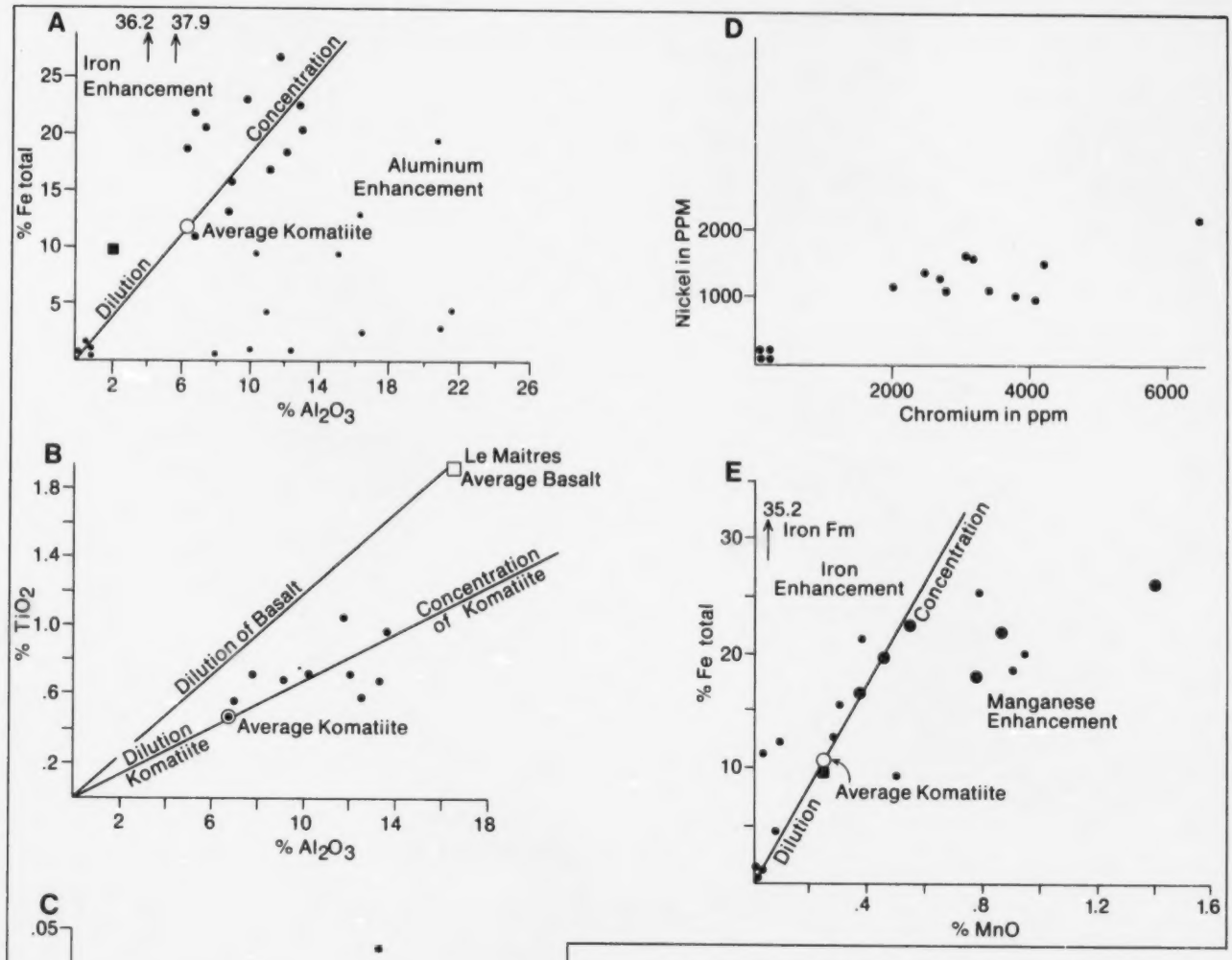
A simple hypothesis for the provenance of the greenschists and amphibolites is that they are weathering products of the underlying gneisses and the indigenous komatiites.

Chemical weathering removes soluble ions and concentrates the remainder, while maintaining the ration of the parent material. In Figure 25, the greenschists and amphibolites plot near a line tracing the progressive enrichment of alumina with increasing removal of soluble cations by weathering processes. In Figure 26 it is shown that the ratios of FeO_{total}/Al_2O_3, TiO_2/Al_2O_3, V/Al_2O_3, Cr/Ni and FeO_{total}/MnO of the greenschists are similar to those in komatiites. The behaviour of iron during weathering is complicated by the interrelationship of pH and Eh. Oxidation stabilizes iron in an insoluble ferric state, in which case it does not tend to form silicates, but rather persists as oxide or hydroxide. Reduction, on the other hand, renders it potentially mobile in the ferrous form, probably as a bicarbonate. On Figure 26a Al_2O_3 and total iron are correlated, which suggests that they behaved in a similar way in the environment, that is, they remained immobile. This suggests that oxidizing weathering conditions were maintained in the depositional environment. The layered iron formations on the other hand, contain very little alumina and presumably represent deposits formed after the chemical separation of iron from aluminum. The diagram shows that both oxidizing conditions, which rendered iron immobile, and reducing conditions, which separated ferrous iron from the weathering products, were operative in the depositional environment. Manganese and iron are similar in chemical behaviour, and can only be separated by differential oxidation of solution (Krauskopf, 1957). Figure 26e illustrates some greenschist samples that plot along the concentration line from komatiites, which shows that iron and manganese have not been separated from each other, whereas the layered iron formations contain virtually no manganese. The high values of chrome and nickel in the rocks are remarkable. The average chrome and nickel content for all rocks in northern Keewatin is 52 ppm and 13 ppm respectively, and for Archean rocks on the Canadian Shield the tenor of chrome is 88 ppm and the tenor of nickel 23 ppm (Eade and Fahrig, 1971). Basalts, for instance, contain as a maximum 550 ppm chrome and 200 ppm nickel, according to Prinz (1968). Nickel and chrome enrichment in the ironstones of Laughland Lake is about 10 to 100 times that of ordinary rocks (Fig. 26d). This enrichment is best correlated with initially high values of chrome and nickel in the provenance, i.e. in the komatiites. Today, the deep lateritic weathering completely alters the trace and major element geochemistry, mineralogy, and structure of the original bedrock. In general, mobile elements such as magnesium and calcium are leached from the system and immobile constituents such as vanadium, chromium, iron and alumina are left as residual accumulations. Elements with intermediate mobilities such as copper, nickel and silica are only partially leached and tend to be redistributed within the weatnering profiles, often to give locally enriched concentrations (Butt and Sheppy, 1975; Wilmshurst, 1975; Cox, 1975). A similar explanation probably obtains for the greenschists and amphibolites of the Prince Albert Group.

The suggestion that Archean hornblendic iron formations from the Keewatin "Series" (Superior Province) which contain relatively large amounts of alumina, may be metamorphosed laterite deposits was first made by Van Hise and Leith (1911, p. 515).

Pelites

Some of the pelite analyses reported in this study (Table 10) are more aluminous than the average pelite (Shaw, 1956), suggesting that any leaching and/or physical sorting that has occurred has been more effective for these rocks than for normal shales. Such extreme chemical differentiation suggests that intense chemical activity took place in a relatively short period of time or that normal weathering processes were operative and occurred over a long time. Calcic schist units may reflect calcareous pelites (Table II). Both types grade into iron-rich types.



A – Total iron and alumina are correlated, circle and square are komatiites – large dots – iron-rich sediments, and small dots – pelites. Note cluster along "concentration line".

B – Titania and alumina in samples cluster along komatiite ratio.

C – Relations between vanadium and alumina.

D – Chrome and nickel tenors are high.

E – Manganese and iron are correlated, but locally, manganese values have been enhanced. This effect is possible only by differential oxidation of solutions carrying both elements.

***Figure 26.** Scattergrams showing relations between selected elements in iron-rich sediments and komatiites.*

The chemistry of Phanerozoic and recent shales from fresh marine depositional environments differ in that marine sediments have a higher lithium and boron tenor than freshwater sediments (Keith and Degens, 1959). The low boron and lithium content (Fig. 27) suggests that the pelites of this study area were deposited in freshwater.

Summary of Mode of Origin of Prince Albert Group

In the preceding pages the mode of origin of each lithological category has been discussed. The Prince Albert Group has been formed in a manner common to them all.

Two models are considered: 1) an oceanic model proposed by Burke and Dewey (1972) which at first glance appears to adequately account for the rock types encountered in the area; and 2) a subaerial cratonic model which apparently more closely fits the geochemical data and is preferred in this report.

Oceanic Model

Burke and Dewey (1972) have analyzed old orogenic belts in terms of their sedimentary, igneous, and metamorphic rocks to characterize the tectonic environment in

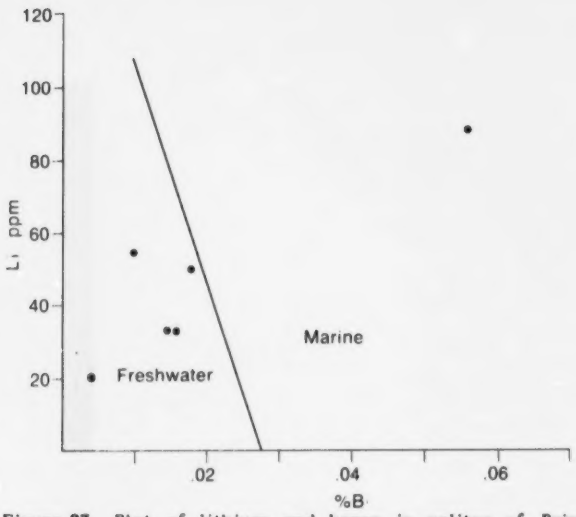


***Figure 27**. Plot of lithium and boron in pelites of Prince Albert Group, showing their apparent impoverishment in both trace elements. Line separates trace element concentrations of pelites deposited in freshwater from those laid down in marine waters (Keith and Degens, 1959). The grey tone is lower limit of detection of analytical method used for boron.*

which they formed by analogy with occurrences of similar rocks in modern tectonic environments. They considered a variety of types of tholeiitic pillow lavas, including spilites cut by abundant dolerite, gabbroic and ultramafic intrusions, as characteristic metavolcanics of an accreting plate margin. Associated deep sea sediments include iron-bearing cherts, limestone, manganese and carbonaceous mudstones and locally developed sulphide belts. Fuchsite quartzites are said to be a marker lithology of suture zones. On the basis of the presence of iron formations, manganiferous sediments, carbonates, local sulphide belts, and chromian-muscovite-bearing quartzites, the rocks of Prince Albert Group would presumably be considered rocks characteristic of an "accreting plate" margin which has subsequently collided with another continental mass to form a suture zone.

The Prince Albert Group in the Walker Lake-Laughland Lake area is not considered to be formed in deep water oceanic environment, for the following reasons:

1. The relatively thin group is deposited on a gneiss terrane.
2. No sheeted dyke swarms or other ophiolitic characters have been noted but komatiite dykes are seen to cut the underlying gneisses.
3. Komatiites are the only volcanic rock present.
4. The subaerial clastic origin of the quartzites proposed earlier in this paper is in direct contrast to Burke and Dewey's model of these units as deep water chromiferous cherts.
5. Low temperature hydrothermal experiments of the type expected in abyssal hot spring environments, show that altering basalts accumulate magnesium from seawater (Bischoff and Dixon, 1975). Therefore, magnesium should be enriched rather than leached, as occurs in the Prince Albert Group greenstones.
6. Trace elements in pelites suggests freshwater genesis; trace elements in iron-rich rocks are not those expected from ocean deposits.

Subaerial Cratonic Model

The preferred model favoured by consideration of the distribution and types of lithologies and their trace element concentrations outlined previously is one which features weathering of gneissic uplands and komatiitic volcanoes and the deposition of this detritus in local basins.

The komatiite dykes, sills, and flows are derived from deep (about 90 km) within the mantle and emplaced through deep cracks (north-south fault) on and in sialic crust.

Fractionated sills near the base of the group and flows throughout the section are especially concentrated near the ancient deep-seated crustal discontinuity (the north-south fault).

The komatiitic flows and basement gneisses were deeply weathered in a topographically varied region so that Eh and pH varied considerably in the depositional milieu. Highly leached blocks and derived sediments from the ultramafic volcanic piles were mixed with well sorted and sedimentarily differentiated weathering products of gneisses. Diagenetically derived solutions moved iron and manganese and colloidal silica through the detritus into local lakes where banded iron formations were precipitated, possibly in the manner postulated by Hough (1958). Organic activity facilitated formation of reducing environments and local development of small pods of sulphide and probably mediated the precipitation of sedimentary carbonate units. The Laughland Lake-Walker Lake rocks possibly grade into shallow marine types near Committee Bay (Campbell and Schau, 1974).

GEOLOGICAL HISTORY OF THE PRINCE ALBERT GROUP IN THE LAUGHLAND LAKE AND WALKER LAKE AREAS

Introduction

Part of the geological history can be inferred from a study of deformation and metamorphism of the Prince Albert Group in the map area (Fig. 28, 29). The three regions discussed, northwestern, eastern, and western, are separated by the north-south fault and the Kellett Fault (Heywood and Schau, 1978). Each region shows a characteristic structural style varying from almost planar steep and northeast-trending in the northwestern region through dominant, tight, upright, subhorizontally-plunging, northeast-trending structures of the Prince Albert Group, to multiply deformed, relatively open folds in the western region. Similarly, each region is differently metamorphosed. Maximum intensity of metamorphism, although everywhere partially retrograded to greenschist, reached amphibolite grade in the northwestern region and in the Prince Albert Group of the eastern region, and greenschist to minor amphibolite in the supracrustals of the western region. This lower metamorphic grade and less intense deformation of the Prince Albert Group allow a glimpse of the amphibolite grade gneissic basement upon which deposition occurred. These variations in postdepositional history, taken in conjunction with the interpretation of the nonmarine mode of origin of the Prince Albert Group, make it possible to provide a provisional geological history of these rocks in the map area.

Structural Elements

Border Faults

The faults that bound the regions appeared relatively early in the history of the area. The north-south fault appears to have acted as a conduit for gabbro stocks and komatiitic lavas, and was sporadically active until after the formation of gneisses from the Prince Albert Group. It is paralleled by a fracture cleavage; minor folds with vertical axes and dextral and/or sinistral senses of movement are

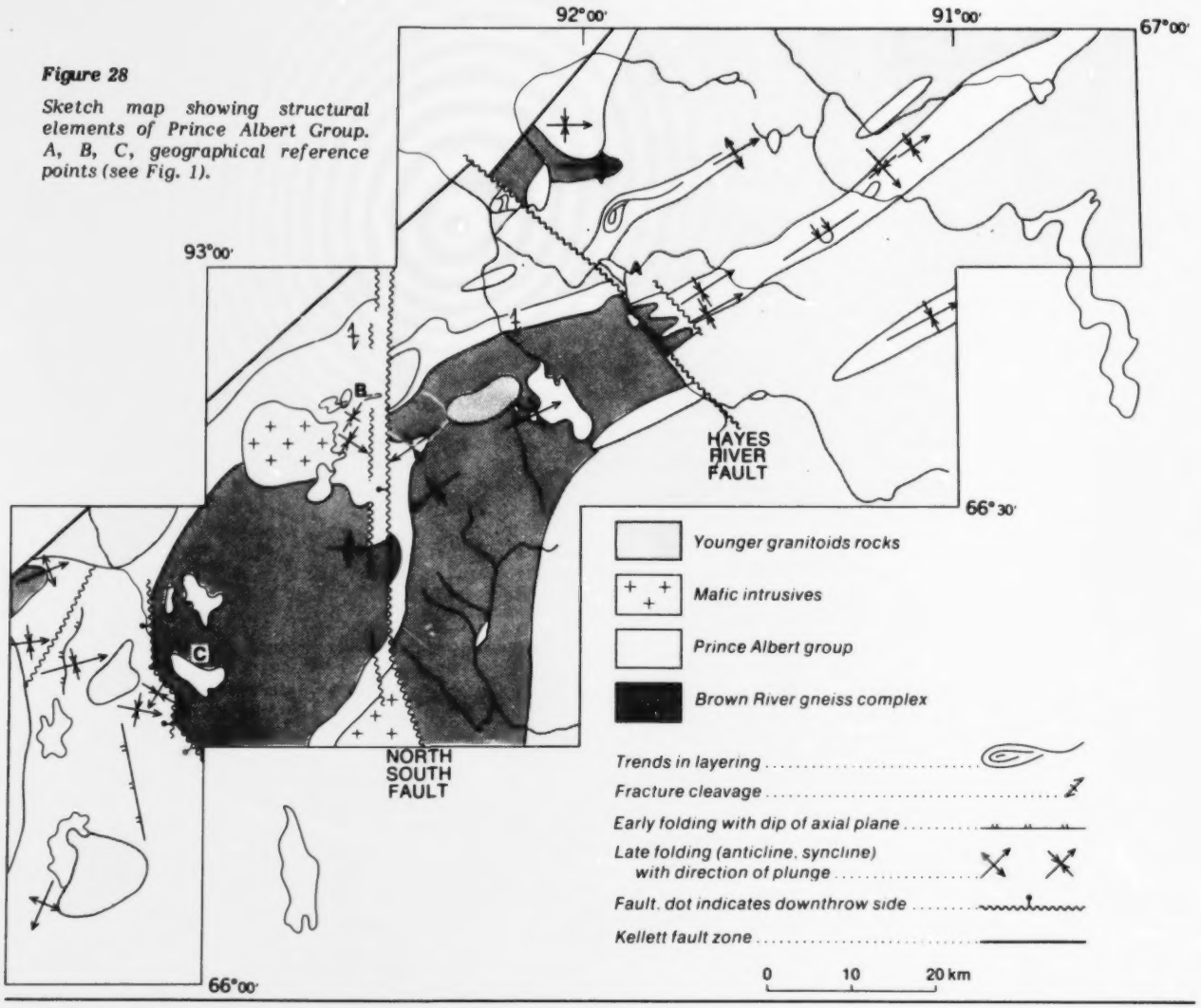


Figure 28

Sketch map showing structural elements of Prince Albert Group. A, B, C, geographical reference points (see Fig. 1).

developed in the cleaved rocks. The apparent movement on the fault, as deduced by offsets of the locally easterly-dipping Prince Albert Group, is west side down.

The main movement of the Kellett Fault (Fig. 28) postdates the development of the Walker Lake Gneiss Complex and predates a small granitic stock, the Hayes River fault and metagabbro dykes. It is interpreted as a narrow annealed mylonite zone and is probably associated with the earliest development of the Ford fault (Heywood and Schau, 1978).

The intersection between the two major fault systems is not exposed but the north-south system appears to be both older and younger than the Kellett Fault.

Northwestern Region

Gneissosity, tabular feldspar crystals, and biotite flakes in the northwestern region have northeasterly trends and steep dips parallel to the Kellett Fault.

Eastern Region

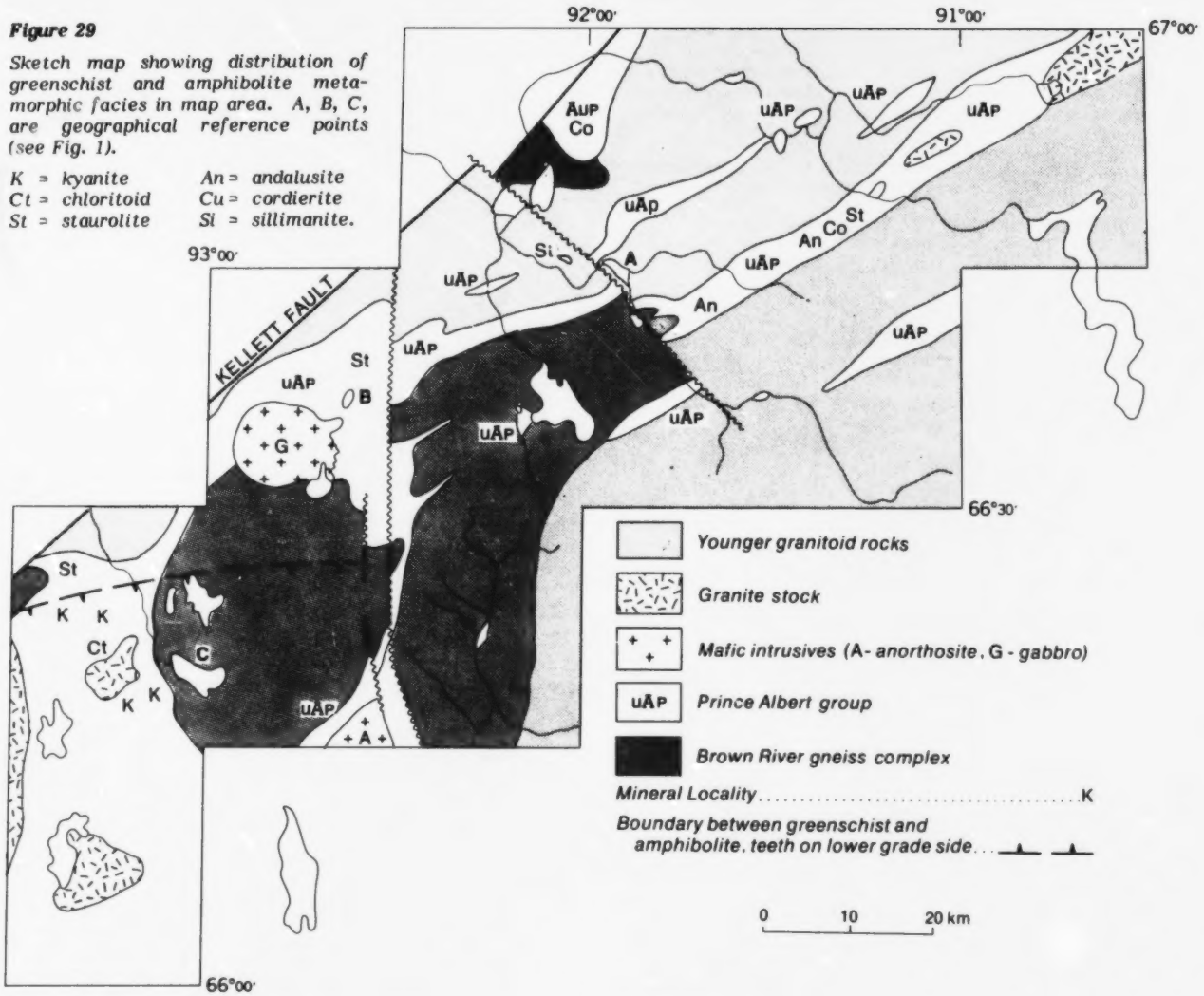
In the eastern area, northeast-trending synclinal keels of Prince Albert Group are set in new gneisses in part formed from Brown River Gneiss Complex. Faults normal to this northeast trend, such as the steep northwest-trending Hayes River fault and a subparallel fault immediately to the northeast, displace all layered rocks with an apparent dextral movement along traces marked by carbonate cemented breccias or by a metagabbro dyke. Mackenzie dykes also trend northwest.

Folds of several generations are present in the region. Sheared metagabbro dykes and felsic veins in the vicinity of late granites are locally folded and contain an anisotropic southeast-plunging magnetic fabric (Schau, 1975c). Small south to southeast-plunging folds present in metakomatiite schists appear to represent the latest fold event. Folds in the Walker Lake Gneiss Complex differ in the northern, central and southern parts. In the northern part folds are tight, generally trend northeastward, with steep axial planes, but are locally divergent, such as northwest of A (Fig. 28) where

Figure 29

Sketch map showing distribution of greenschist and amphibolite metamorphic facies in map area. A, B, C, are geographical reference points (see Fig. 1).

K = kyanite *An = andalusite*
Ct = chloritoid *Cu = cordierite*
St = staurolite *Si = sillimanite.*



shallowly dipping gneissosity characterizes several square kilometres. South of A (Fig. 28) new axial plane foliation defined by biotite is formed across the folded gneissosity. The foliated granitic areas appear concordant with the layered gneisses. The central portion is underlain by relatively massive foliated granitoid bodies and well layered, steeply dipping, schist-rich gneissic remnants of the Prince Albert Group aligned along northeasterly trends. Local contortions are present, but few folds are obvious. Augen gneiss along the southern boundary of the central gneisses may represent the locus of an east-west ductile fault zone. The southern portion is underlain by essentially flat lying gneisses with mafic layers containing porphyroblasts of potash feldspar, by flattened and complexly deformed pegmatites of several generations, and by relatively massive granitoid rock such as might occur near the roof of a large batholith. The folds in the Prince Albert Group are generally tight, with steeply dipping, northeast-trending axial planes and shallow, doubly plunging axes. Mesoscopic folds are complex and locally, layered iron formation contains evidence of three or more axes of deformation. Metakomatiite schist in enclaves in gneiss northwest of point A outlines a small refolded isocline. Near plutons the folds show complex outcrop patterns.

Western Region

Structures have developed at different times in the western region. North-northwest-striking faults with apparent movement of west side down (near point C, Fig. 28) cut sheared gabbro stocks, folded quartzites of the Prince Albert Group and Brown River Gneiss Complex. A northeast-striking fault with probable dextral movement (west of point C, Fig. 28) offsets the folded Prince Albert Group and may predate the granodiorite pluton at the extreme western edge of the map area. Abundant lineaments with north-northwest trends may mark traces of faults but direct evidence for relative movement has been masked by glacial debris.

The supracrustal rocks are multiply deformed. A late shallow, east-plunging fold set with wavelength of several kilometres is well exposed west of point C (Fig. 28). Near point B (Fig. 28) subhorizontal, tight, east to northeast-plunging folds probably represent the same folding event. In both regions there are suggestions of earlier fold sets. Northwest of Laughland Lake northerly trending, tight, overturned refolded folds with folded axial plane cleavage are locally preserved (Fig. 8). Near B (Fig. 28) earlier folding is

deduced from mesoscopic and minor fold structures with anomalous orientations. Northerly trending beds folded about east-plunging folds are locally preserved along the north-south fault.

Metamorphism

Northwestern Region

The Kuagnat Gneiss Complex is metamorphosed to amphibolite grade. A more porphyroblastic phase near the northeast boundary of Laughland Lake map area may have reached upper amphibolite grades.

The higher grade metamorphism is coeval with deformation, and diaphthoresis to greenschist or lower grades is widespread.

Eastern Region

The metamorphic history of the eastern region includes progressive regional metamorphism of gabbro stocks, the Prince Albert Group, and the regression of the Brown River Gneiss Complex to mainly lower amphibolite mineral assemblages. Upper amphibolite mineral assemblages do occur near the Kellett Fault and to the northeast of the map area (Schau, 1978). The region is characterized by porphyroblastic and schistose or gneissose textures, and andalusite aluminosilicate (except sillimanite, which is found locally near Kellett Fault). Thermal aureoles surround several granitoid plutons.

The amphibolite grade mineral assemblages have been described briefly in the section devoted to general geology. Gabbro stocks were incorporated in the gneissic terrane. The resistant Prince Albert Group rocks such as quartzites, iron formations, and metakomatiite schists, persist as inclusions or keels of subhorizontal synclines in the gneissic terrane.

The northern gneisses of the Walker Lake Complex are composed of large proportions of both new amphibolite grade gneiss and granitoid material at amphibolite grade, and subordinate amounts of amphibolite grade Prince Albert Group and Brown River Gneiss Complex rocks. The central gneisses of the Walker Lake Gneiss Complex are mainly amphibolite grade gneisses consisting of Prince Albert Group, Brown River Gneiss Complex and granitoid gneisses of uncertain heritage. Southern gneisses are amphibolite grade and in large part were once mobile. Their source includes Prince Albert Group and granitoid rocks of uncertain heritage.

Regional metamorphism in part was contemporaneous with deformation that formed mineral foliation, and in part outlasted deformation, as shown by biotite, anastomosing olivine, potash feldspar, and andalusite porphyroblasts that transgress foliations.

Amphibolite grade thermal aureoles are associated with muscovite granite. The terrane cooled sufficiently to allow emplacement of planar, mafic dykes.

The Late Granite thermally remetamorphosed the country rock. One result is the very high initial strontium isotope ratio (.8260) preserved in metakomatiite schist near such a late pluton. Metagabbro dykes were affected by the Late Granite and have been altered to hornblende hornfels grade mineral assemblages in the aureoles. The minor southeast-plunging folding and the emplacement of the granites are probably related since quartz feldspar veins from the granite were emplaced in the sheared metagabbro dykes. Shearing and jostling associated with the emplacement of the late granitic plutons and/or the latest movements on the great shear systems of the northern Churchill Structural Province which may contain coexisting chlorite and potash feldspar and/or epidote, indicate that the region has been locally degraded to greenschist grade.

Western Region

The metamorphic grade of the western region is generally lower than the other regions. Upper greenschist regional metamorphic assemblages in the gabbro and anorthosite stocks, the Prince Albert Group and the Brown River Gneiss Complex grade into amphibolite mineral assemblages near the Kellett Fault. Locally observed small thermal aureoles surrounding granitic plutons appear to have been imposed on the metamorphic country rocks.

The western region is characterized by phyllitic textures and kyanite. The greenschist grade mineralogies, are best seen in the pelitic or ultramafic rocks of the Prince Albert Group, but also occur in the gabbro and anorthosite stocks and in partly degraded gneisses of the Brown River Gneiss Complex. The regional metamorphism both predates and postdates the fold deformation since metamorphic minerals such as kyanite are strained and broken, and undeformed amphibole rosettes grow across foliation associated with the east-plunging folding.

In the metamorphic aureole of the tonalite pluton west of point C (Fig. 29) kyanite-bearing quartzite suggests that this part of the pluton was emplaced at or deeper than the aluminosilicate triple point.

Comparison of Regions

The western region was apparently metamorphosed at slightly higher pressures than the eastern region. Maximum temperatures reached in the Prince Albert Group containing thermal aureoles and near the Kellett Fault in the western region, overlap those attained on a regional scale in the Prince Albert Group in the eastern region (Fig. 13). These generalizations suggest: the eastern region is on a flank of a thermal dome (whose culmination is to the northeast near Committee Bay (Schau, 1978)) whereas the lowest grades occur in the western region; the earlier structures in the western region have been obliterated by greater strain and more complete recrystallization in the tightly folded eastern region; the western region has been uplifted somewhat more than the eastern region; and since the apparent movement on the northerly striking faults is generally west side down, it is suggested that there was a regional easterly tilt of a few degrees.

Geological History: A Model and Some Regional Implications

The Brown River Gneiss Complex, which records a history of plutonic activity predating the Prince Albert Group, presumably extended over a large area. The Prince Albert Group was deposited on this gneiss in a terrane of variable topography and local lakes. Komatiitic lavas locally formed low mounds which, when weathered, acted as source material for aluminous iron-rich sediments. Weathering and sedimentary differentiation of gneiss and komatiite produced pure quartzites, aluminous pelites and layered iron formations.

The well differentiated sediments of the Prince Albert Group suggest that they were deposited in a tectonically quiescent region. Immature sediments and a larger volcanic component to the northeast on Melville Peninsula indicate that gradients in tectonic stability existed over hundreds of kilometres at the time of deposition of the Prince Albert Group.

Near the end of Archean time the region was again tectonically active. The Prince Albert Group was depressed 15 to 20 km into the crust (some 5 to 7 times its stratigraphic thickness). Since late Archean and earliest Proterozoic sediments are lacking in the mapped area it is likely that this depression was accomplished by some form of tectonic

thickening or stacking. Shallow-dipping axial planes and overturned folds preserved northwest of Laughland Lake may represent such relict stacking structures.

Steeply dipping northeast-trending structures are the best developed in the map area. In the western region they postdate the earlier shallow-dipping structures; in the eastern region any earlier tectonic history is obliterated. There, the structures appear coeval with the gneissification and the peak of metamorphism. Perhaps uplift and other effects associated with the development of high grade metamorphic culmination to the northeast near Committee Bay (Schau, 1978) is responsible for the apparent lower pressure of metamorphism in the eastern region of the map area.

Preliminary age assignments of Archean supracrustal groups (Wanless, 1979) suggest that formation of the Walker Lake Gneiss in the map area, and related events on Melville Peninsula, were coeval with the time of deposition of the Yellowknife and Kaminak groups to the west and south.

Well differentiated, early Proterozoic supracrustal rocks in northern Churchill Structural Province are present nearby and suggest that uplift took place at relatively slow rates.

Northwesterly directed faulting and emplacement of north-northwest-trending dykes took place in relatively brittle crustal environments in early Proterozoic time.

Emplacement of small granitic stocks (with local metamorphic aureoles ranging up to amphibolite or hornblende hornfels facies), regional shearing, minor jostling and minor fold development and partial degradation of gneisses and other metamorphosed rocks to greenschist grade mineralogies, is in part dated by the mid-Proterozoic potassium-argon dates so characteristic of this region.

The last recorded event in the area was emplacement of the Mackenzie dykes.

There is no evidence of inundation by early Paleozoic epeirogenic seas or the later block faulting which affected areas to the north and east of the mapped area.

Glacial processes have accentuated the north-northwest grain of the land.

MINERAL SHOWINGS AND RESOURCE POTENTIAL

Introduction

The region contains scattered sulphide occurrences and has been visited by a number of mining companies subsequent to Heywood's (1961) seminal report. The potential for the occurrence of economic minerals in this area is judged low. Laporte (1974a,b) has reviewed the details of exploration activity in the area.

Brown River Gneiss Complex

The Brown River Gneiss Complex contains no known sulphide showings. Magnetic anomalies in covered regions are mapped as part of the complex. Preliminary studies with a broadband scintillometer show that these gneisses may be somewhat more radiogenic than the majority of more recent gneisses in the area (Schau and Campbell, 1974). A metamict mineral tentatively identified as allanite is common in the rocks of the complex. The mineral potential of the Brown River Gneiss Complex is low.

Prince Albert Group

The Prince Albert Group contains a variety of showings. Metakomatiite schists contain calcite veins and minor chalcopyrite and pyrite. Metasediments contain iron sulphide and oxide lenses. Magnetic anomalies are noted over iron formations and magnetite-rich metakomatiites. Chemical analyses of metasediments show them to be anomalously high in Ni and Cr. The presence of metakomatiites has led Eckstrand (1975b) to conclude that "...the nickel potential of the Prince Albert Group must be regarded as significant because of the nature and environment of the contained ultramafic rocks. They bear certain similarities to ultramafics containing nickel and sulphide deposits in a number of Archean terrains, including the Abitibi orogenic belt in Ontario and Quebec, the Yilgarn and Pilbara blocks of western Australia, and the Rhodesian Craton. Some of the points of similarity are the following:

1. A large proportion of the ultramafics are conformable lenses, and many of these are demonstrably extrusive.
2. The ultramafics are part of a supracrustal suite of rocks comprising volcanics and siliceous and other sediments, including iron-formation (Campbell and Schau, 1974).
3. The ultramafic rocks are commonly found in close spatial association with oxide or sulphide iron-formation and sulphide-rich sediments (Campbell, 1974).

Because of these similarities it is reasonable to expect that some nickel sulphide deposits similar to those in the other terrains might also be found in the Prince Albert Group ultramafics. Such deposits could be either of the Kambala type, associated with flows, or of the Mt. Keith type, associated with sills...".

However, in the Australian Yilgarn Block minor elements (Ni, Cu, Cr) are concentrated by weathering to form anomalously rich soils in regions not associated with nearby sulphide deposits (Butt and Sheppy, 1974). It is postulated that the sediments of the Prince Albert Group might have formed in a similar milieu. Thus the anomalous trace element values encountered in the Prince Albert Group sediments may be fossil geochemical haloes due to Archean lateritic weathering of the komatiites and not necessarily reflect nearby sulphide deposits. Exploration for nickel deposits would be difficult.

The iron formations contain low concentrations of hematite, magnetite, pyrite and locally pyrrhotite.

In summary, there is a possibility that nickel and possibly copper deposits may be present in or near the metakomatiites. Economic concentrations of Fe, Pb, Zn, Mo, Ur, Co, Cu in the Prince Albert Group are thought less probable.

A pale green to grey soapstone deposit, 3 m by 3 m outcrops near the Hayes River in northwest corner of 56J. A small amount was shipped to Repulse Bay in 1973 where it was easily carved by the local practitioners.

Extremely pure quartzite could be used as metallurgical flux.

Gabbro and Anorthosite Bodies

Chalcopyrite is sparingly distributed through gabbro but neither chromite nor ilmenite were recognized in the anorthosite plug.

Kuagnat Gneiss Complex

No mineral showings were noted in the brief survey of these granitic gneisses.

Walker Lake Gneiss Complex

Pyrite, rare molybdenite, and possibly chalcopyrite(?) coat joint surfaces in a sphene-bearing granitic gneiss in north-central part of Walker Lake map area. A cold acid extraction of fine grained stream sediments and swampy

materials in the general area was tested with dithizone solution. Results indicate no concentration of heavy elements in these materials.

The local seriate nature of the granite and the localization of sulphides along joint surfaces suggests that low grade deposits of molybdenum may be present.

Some anomalies in the regions underlain by the Walker Lake Gneiss Complex are caused by up to 7 per cent magnetite concentrations in the granitic gneisses (Schau, 1975c) but not all aeromagnetic anomalies were investigated.

Scintillometer readings are generally low in these gneisses. The area underlain by the southern part of the Walker Lake Gneiss Complex contains purple fluorite-bearing gneissic granites. Pegmatites in this region gave high scintillometer readings but the radioactive mineral has not been identified.

Granitic Plutons

Arsenopyrite is found in the margin of a small "high level" pluton. Skarns are developed along the east contact of the main body of muscovite granite, and sulphide rich layers in the Prince Albert Group are within the metamorphic aureole. The potential of the granite plutons is low.

Metadiabase Dykes

Opaque minerals in the dykes include pyrrhotite and magnetite. No silver or cobalt anomalies in analyzed rocks have been noted. The mineral potential of these dykes is low.

Late Granitic Plutons

The late granitic plutons characteristically weather red, in part because of weathering of scattered pyrite grains. The mineral potential of this unit is low.

Mackenzie Dykes

No deposits are known associated with the Mackenzie dyke swarm. The mineral potential of this unit is low.

Alluvium

Industrial materials such as sand and gravel are locally abundant. The reader is referred to publications by Thomas (1977) for an assessment of the distribution of such materials.

Summary

The area is not a typical greenstone belt. The possibility of nickel deposits exists but sophisticated methods will be necessary to separate them from the fossil allochthonous geochemical haloes that may be present in region. Showings of arsenopyrite and molybdenite are indications that granitic rocks are not necessarily barren. The somewhat higher radiometric background on Brown River gneisses and the existence of purple fluorite in southern regions of the Walker Lake Gneiss Complex suggest that the area may possibly be a source of radioactive minerals for sediments derived from this region. The older supracrustals in the area have not been found to be enriched in radioactive minerals.

Reports of mining companies who have worked in the area include:

N 019664 Aquitaine Company of Canada Ltd., Wager Bay area, Permits 231-234 (56J/11, J/12, K) Airborne E.M. and Mag. reports, 19 maps at 1" = 20 000* by K. Danda and J. Klein, IAND, Ottawa, 1971.

N 019679 Aquitaine Company of Canada Ltd., Hayes River area, Permits 231-234 + claims (56J and K) Geology and ground Mag. + air EM and DDH records by A.E. Boerner, IAND, Ottawa, 1971.

N 060783 King Resources Company, Curtis Lake area (56I/11, J/13, 56J/15, 56K/7-10, 56P/4-9), Geology + air and ground EM and Mag. 36 maps variable scales by W.C. Brisbin, IAND, Ottawa, 1970.

N 061390 Cominco Ltd., Hayes River area, Permit 349, (56J/13), Geology and rock geochemistry and ground EM and Mag. 4 maps various scales by V. Grosh and W. Porng, IAND, Ottawa, 1975. (Confidential until March 31, 1981).

N 019678 Aquitaine Company of Canada Ltd., Hayes River area 56K/7, HAR group Ground EM and Resistivity survey, 40 maps by Tech-No. IAND, Ottawa, 1971.

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APPENDIX

Analytical precision, accuracy and sample variability

All analytical results in the following tables are derived from work carried out by the staff of the Analytical Services Section of the Geological Survey's Central Laboratories and Technical Services Division.

Analyses cited in this report are accurate to within the limits stated in column 3, Table 1. This column is derived by continuous monitoring of international standards by the current analytical method. A replication experiment was performed by the author which shows that laboratory precision is better (column 2, Table 1) than the accuracy claimed by laboratory. This experiment involves the analysis of 3 sets of each side of 2 fused discs of each of 2 pieces from the same hand specimen. This result suggests that homogenization of powders during crushing and fusion is satisfactory.

The samples submitted for chemical analyses are hand specimens from which a thin section is made, usually a slice is saved, and the remaining material is trimmed of weathered material by sawing or grinding. This sample is then crushed to -250 mesh. These powders are the materials analyzed.

The major elements are analyzed by a highly automated X-ray fluorescence method developed in the Geological Survey (XRD-S30). CO_2 is determined by acid evolution and titration, H_2O by fusion in a Penfield tube and a Karl Fisher titration, FeO by cold acid decomposition and back titration with $K_2Cr_2O_7$, and F and Cl by carbonate fusion and determination by selective ion electrodes. Trace elements are determined mainly by a semiautomatic optical spectroscopic method (the 12B-Dr system) and precision is quoted at 15%. Some of the minor elements were analyzed by XRF and precision quoted was ↶10%. Elements run by both methods yield the same values considering the variabilities cited. The spectroscopic results have been cited in this report. Volatile elements are determined by a special spectroscopic technique with a precision of ±30% or by screw rod on atomic absorption with a precision of ↶10%.

Different batches of analyses have been reported and when comparing between batches it is prudent to use the variability estimates of column 3. The author has not monitored any shifts in variability but the laboratories are continually upgrading and revising their methods so that samples from each batch are not necessarily analyzed the same way, and analytic variability should be decreasing with time.

The following are the batches reported: 73-47, 74-21, 43-75, 66-76, 72-76.

Table 1. Limits of analytical precision, accuracy and sample variability

	Variability[1] due to split (hand specimen variability)	Variability[1] of analysis (Precision)	Lab. reliability[2] (G. Lachance, pers. comm. 1976) (Precision of Standards)
SiO_2	± 1.0	± .2	± .7
Al_2O_3	± .2	± .04	± .5
TiO_2	± .04	± .00x	± .03
Fe_2O_3	± 1.93	± .17	± .2
FeO			± .2
MnO	± .09	± .00x	± .02
MgO	± .59	± .11	± .4
CaO	± .48	± .05	± 0.1
Na_2O	± .14	± .01	± .3
K_2O	± .05	± .00	± .03
P_2O_5	± .13	± .03	± .03
CO_2	± .14		± .04
H_2O	± .07		± .04
S	± .02		± .03
Cr_2O_3	± .01		± .03
F			± .01
Cl			± .01

[1]From Analysis of variance of data set reported in test.
[2]Laboratory estimate updated to 1976.

Table 2. Chemical analysis of selected Brown River Gneiss Complex rocks

	1	2	3	4	5	6	7	8	9	10	11
Major Elements %											
SiO_2	60.90	63.50	64.50	64.10	66.30	70.80	74.00	72.04	70.65	72.01	72.40
TiO_2	.47	1.04	.76	.74	.57	.53	.08	.23	.28	.22	.21
Al_2O_3	20.50	16.10	17.20	17.40	17.50	16.00	15.20	15.23	15.39	15.48	14.97
Fe_2O_3	.90	1.30	.60	.30	.70	.50	.20	.49	.52	.50	.45
FeO	2.10	2.50	2.80	3.20	2.00	1.50	.50	1.10	1.30	.90	1.00
MnO	.04	.05	.07	.06	.03	.01	.00	.05	.06	.04	.04
MgO	1.72	2.39	1.87	2.06	1.80	1.10	.37	.78	1.05	.68	.67
CaO	3.21	4.26	3.87	3.74	4.12	2.91	1.12	.03	1.91	1.72	1.96
Na_2O	7.30	4.90	5.20	5.40	5.20	4.70	4.50	4.58	5.11	4.92	4.79
K_2O	1.95	2.05	1.98	2.50	1.85	2.45	4.69	3.06	2.68	2.62	3.04
P_2O_5	.18	.63	.47	.65	.34	.17	.04	.09	.10	.09	.07
CO_2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
H_2O	.50	.90	.80	.60	.50	.50	.30	.20	.50	.90	.20
S	.11	.00	.09	.08	.02	.00	.00	.01	.01	.01	.01
Minor Elements											
Co %	tr	tr	.0011	tr	tr	tr	tr	tr	tr	tr	tr
Ni %	tr	.0027	.0021	.0013	tr	tr	tr	tr	tr	tr	tr
Cu %	.0008	.0012	.0013	.0011	.0011	.0018	.0010	tr	tr	tr	tr
Cr %	.0010	.0035	.0013	.0013	.0012	.0007	.0005	tr	tr	tr	tr
V %	.0053	.0064	.0068	.0061	.0044	.0029	tr	tr	.0025	tr	tr
Sc %	nd	nd	nd	nd	nd	nd	nd	.0006	tr	tr	tr
Rb ppm	87	66	96	80	87	68	90	121	112	117	119
Sr %	.0618	.0626	.0658	.0480	.0821	.0245	.0255	.0360	.0340	.0320	.035
Ba %	.0384	.0602	.0763	.1100	.0528	.0665	.0547	.067	.059	.059	.072
Zr %	.0603	.0379	.0280	.0417	.0363	.0216	.0843	.016	.016	.013	.012
Li ppm	41	46	46	36	35	31	11	52	46	45	40
Cs ppm	5.5	4.3	4.6	2.9	9.6	1.5	1.8	nd	nd	nd	nd
Zn ppm	52	60	75	77	83	62	nd	42	49	46	35
Pb ppm	8.2	10	48	9.7	9.3	8.2	39	.14	.11	.12	.15
Cl %	nd	nd	nd	nd	nd	nd	nd	.01	.02	.02	.01
F %	nd	nd	nd	nd	nd	nd	nd	.08	.08	.06	.06

2-1[1]; 66-76-40[2]; 3-8005A[3]; 527370[4], 7382540[5]. A leucocratic layer of degraded biotite-bearing porphyroblastic monzodioritic* gneiss composed of poikiloblastic and relict plagioclase, potash feldspars, graphic granite intergrowths locally altered to clays and white mica, with green pleochroic biotite degraded to chlorite with purple-black birefringent chlorite, opaques rimmed with sphene or leucoxene and speckled with epidote and accessory apatite, zircon, hematite and allanite? (SG = 2.66).

2-2; 66-76-42; 3-8007; 526500, 7381850. Degraded biotite-bearing poikiloblastic tonalitic gneiss composed of strained and annealed plagioclase and quartz with biotite, sphene and rare hornblende and accessory apatite, epidote, allanite and zircon (SG = 2.65).

2-3; 66-76-36; 3-8002; 526950, 7383100. Degraded biotite-bearing porphyroblastic tonalitic gneiss with lenticles of finely layered epidote and pyritic biotite-rich layers cut by granitic sills (see 2-7).

2-4; 66-76-38; 3-8011; 526900, 7380950. Degraded biotite-bearing porphyroblastic tonalitic gneiss with epidote-rich layers and pyritic biotite lenticles set in plagioclase quartz matrix (SG = 2.66).

2-5; 66-76-37; 3-8006; 527200, 7382020. Degraded biotite-bearing porphyroblastic tonalitic gneiss composed of plagioclase, quartz, green biotite, with opaques rimmed by sphene or leucoxene, accessory epidote, apatite, zircon, hematite, allanite and monazite?

2-6; 66-76-39; 3-8009; 526830, 7381500. A leucocratic layer of epidote-speckled, massive, fine grained granodioritic gneiss composed of quartz, poikiloblastic plagioclase, microcline locally altered to clay and white mica, green biotite altered to chlorite, opaques rimmed by epidote, and sphene with accessory zircon, apatite, hematite, allanite.

2-7; 66-76-41; 3-8002; 526950, 7383100. Degraded aplitic granite layer cutting 2-3 above (SG = 2.63).

2-8; 74-21-188; 3-4024; 542670, 7414190. Crushed granitic gneiss with quartz, relict and recrystallized plagioclase, microcline, graphic granite with chloritized biotite and dotted by sphene, opaques, white mica and accessory zircon and apatite (SG = 2.59).

2-9; 74-21-189; 3-4025; 542670, 7414190. Crushed granitic gneiss with relict and recrystallized quartz, relict and recrystallized plagioclase, microcline, graphic granite, chloritized biotite dotted with white mica, opaques, sphene, epidote and accessory zircon, apatite and allanite.

2-10; 74-21-190; 3-4026; 542670, 4714190. Crushed granitic gneiss with relict and recrystallized quartz, relict and recrystallized plagioclase, microcline, graphic granite, chloritized biotite and dotted with white mica, opaques, sphene, epidote, hematite and accessory zircon, allanite and apatite.

2-11; 74-21-191; 3-4027; 542670, 7414190. Crushed granitic gneiss with relict and recrystallized quartz, relict and recrystallized plagioclase, microcline, graphic granite, chloritized biotite dotted with white mica, opaques, sphene, epidote, pumpellyite(?), and accessory zircon, allanite and apatite.

*Names are after Streckeisen 1976

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 3. Provisional Stratigraphic Section of Prince Albert Group in northern part of Walker Lake map area

100 m	complex structures in core of syncline pelitic schist with biotite porphyroblasts (10-10)
200 m	white quartzite with specks of chromian muscovite, locally cross-bedded, grades along strike to north-east into muscovite schist, contains andalusite in micaceous interbeds (8-7)
500 m	biotite schist with thin layers of garnetiferous schists, silicate iron formation and cordierite-garnet-gedrite schists near top (9-9, 9-18, 9-20)
0-15 m	metakomatiite schists
	CONTACTS UNCERTAIN
	granitoid gneiss

See Figure 6 for location. (Numbers identify table and number of analyzed samples collected in this interval near or on the section.)

Table 4. Provisional Stratigraphic Section of the Prince Albert Group in southern part of Laughland Lake map area

	TOP UNKNOWN
15 m	metakomatiite schist with iron-rich hornblende horizons (6-3)
200 m	sheared gabbro stock
200 m	chloritic phyllite with actinolite-rich layers (Garbenschiefer) (9-19)
100 m	sheared gabbro apophyses (13-1) emplaced in layered amphibolite-rich fragmental units (9-14)
100 m	calcareous fragmental unit with quartz layers, hornblende porphyroblasts and relict fragments now serpentine and carbonate set in a carbonate matrix
10 m	garnetiferous horizon with meta-siltstones interbedded with calcareous or chloritic units near base, quartzose fragments and helicitic garnets set in chloritic matrix (9-5, 11, 12, 16)
100 m	mainly covered; phyllite (10-3, 11-2)
40 m	limestone with vague layers and variable amounts of breccia. Some units well layered on 10 cm to 1 m scale. Some contain both ankerite and calcite
10 m	calcareous chlorite schist
20 m	phyllite
10 m	rusty weathering garnet-rich layer
20 m	quartzose schist
20 m	pyritic amphibole-rich iron formation with garnetiferous layers (9-7)
15 m	schistose quartzite (8-9)
5 m	grey phyllites with local chloritoid
5 m(?)	fine grained amphibolite-rich iron formation (9-13)
150 m	calcareous chlorite schists with scarce quartz-rich layers, or layered amphibole-rich iron formation with occasional garnets (11-4, 9-15)
10 m	lean oxide iron formation
100 m(?)	chloritic metasiltstone (10-4)
15 m	quartzite with muscovite interbeds - local chromian muscovite along strike
1145 m	

See Figure 8 for location. (Numbers identify table and number of analyzed samples collected in this interval on or near the section.)

Table 5. Chemical analyses of metakomatiites of the Prince Albert Group

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Major Elements %														
SiO_2	39.00	40.70	38.40	38.40	41.10	40.30	40.60	38.20	40.80	43.30	42.50	43.10	41.90	41.80
TiO_2	.10	.18	.15	.34	.17	.34	.33	.38	.17	.29	.29	.22	.30	.27
Al_2O_3	2.70	4.10	3.60	11.40	3.70	6.90	5.40	7.40	4.40	6.90	7.50	7.60	7.00	7.00
Fe_2O_3	3.10	5.30	4.80	3.20	3.10	3.00	4.30	4.40	3.90	.35	2.10	1.40	2.80	2.90
FeO	7.70	4.20	4.60	8.90	4.00	7.40	6.60	7.10	4.80	7.60	6.30	6.80	6.40	7.10
MnO	.33	.19	.19	.22	.24	.21	.25	.16	.14	.19	.17	.21	.18	.22
MgO	37.80	38.50	34.70	24.10	33.70	28.10	33.40	27.90	31.60	26.70	26.80	26.90	26.90	26.30
CaO	.44	1.50	1.70	6.90	3.50	5.50	2.50	4.10	4.10	7.10	7.50	7.60	7.10	6.80
Na_2O	.04	.01	.08	.16	.07	.11	.03	.09	.10	.13	.32	.13	.08	.18
K_2O	.01	.01	.03	.02	.01	.02	.01	.03	.01	.04	.05	.01	.03	.02
P_2O_5	.03	.04	.03	.05	.02	.04	.03	.04	.04	.04	.04	.04	.03	.03
CO_2	.00	.03	.05	.00	.07	.00	.05	.00	.14	.00	.00	.00	.00	.00
H_2O	8.20	5.10	11.40	5.10	9.80	7.20	5.80	8.70	9.30	5.80	5.70	5.60	5.90	6.50
S	.03	.06	.14	.01	.18	.08	.07	.11	.03	.02	.05	.03	.01	.14
Minor Elements														
Co %	.010	.0095	.0094	.0071	.0088	.0078	.010	.0096	.0090	.0050	.0074	.0074	.0062	.0061
Ni %	.21	.19	.18	.078	.23	.11	.14	.13	.15	.077	.12	.10	.082	.079
Cu %	tr	.0014	.0032	nf	.0037	.0023	.0035	.061	nf	.009	.0045	tr	.0010	.0070
Cr %	.20	.23	.25	.21	.29	.31	.45	.38	.34	.25	.26	.20	.24	.24
V %	.0071	.011	.011	.023	.010	.020	.016	.025	.013	.017	.021	.014	.017	.017
Sc %	.0016	.0020	.0018	.0033	.0016	.0023	.0022	.0031	.0015	.0025	.0025	.0023	.0024	.0035
Rb ppm	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sr %	nf	nf	.0015	tr	.0018	.0031	nf	tr	.0025	.0021	.0058	.0043	.0023	.0056
Ba %	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zr %	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B ppm	10	22	19	nf	17	6.8	18	22	39	nf	nf	tr	nf	tr
Zn ppm	92	83	59	76	90	91	84	64	44	66	64	68	56	500+
Pb ppm	tr	tr	tr	tr	tr	tr	tr	tr	tr	1.8	tr	tr	tr	tr
Ag ppm	1.5	tr	tr	tr	tr	.072	tr	.42	.60	tr	tr	tr	tr	3.1
Li ppm	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Magnetite	10.5%	10.7%	6.5%	.5%	2.6%	6%	nf	3.9%		6.2%	3.6%	5.6%	4.7%	6.2%

	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Major Elements %														
SiO_2	42.10	42.10	45.00	41.40	43.40	44.60	45.00	45.50	44.60	47.80	47.80	40.64	43.67	44.14
TiO_2	.32	.26	.27	.36	.30	.28	.27	.30	.28	.25	.35	.15	.18	.15
Al_2O_3	5.40	6.20	7.20	6.00	5.80	5.90	6.70	5.60	4.50	4.20	6.10	2.13	1.93	1.77
Fe_2O_3	4.10	2.70	2.50	3.00	3.10	1.60	1.20	1.80	5.00	1.00	1.60	4.08	2.67	2.26
FeO	5.90	7.00	5.90	6.00	6.30	6.20	8.30	7.60	8.30	7.90	7.40	4.20	4.30	4.40
MnO	.25	.21	.19	.17	.22	.19	.17	.18	.20	.15	.22	.20	.17	.15
MgO	28.20	27.40	27.40	42.90	27.20	27.00	25.90	23.90	23.00	24.80	26.00	36.37	36.04	35.98
CaO	6.90	5.80	8.10	7.90	6.50	6.70	5.70	8.10	8.20	7.10	5.62	.48	.61	.67
Na_2O	.24	.11	.18	.23	.20	.08	.09	.02	.35	.06	.30	.02	.03	.06
K_2O	.05	.02	.03	.07	.05	.02	.02	.29	.11	.02	.01	.01	.01	.01
P_2O_5	.04	.04	.03	.06	.04	.04	.06	.04	.08	.04	.05	.03	.03	.03
CO_2	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00	.44	.29	.17
H_2O	6.20	7.40	2.00	9.60	6.70	6.70	5.90	5.30	4.60	6.00	5.20	10.90	9.60	9.60
S	.07	.19	.10	.11	.12	.10	.03	.06	.22	.38	.00	.06	.08	.06
Minor Elements														
Co %	.0077	.0062	.0074	.0074	.0082	.0056	.0058	.0084	.0067	.0094	.0085	–	.0072	–
Ni %	.15	.12	.13	.10	.12	.070	.082	.026	.091	.149	.22	–	.18	–
Cu %	.0040	.0069	.0038	.0032	.0047	.0013	.0045	.0050	.011	.011	.0009	–	.0013	–
Cr %	.28	.22	.25	.25	.18	.23	.20	.029	.16	.20	.17	–	.13	–
V %	.016	.015	.020	.017	.022	.017	.016	.013	.014	.0072	.012	–	.0089	–
Sc %	.0019	.0024	.0028	.0029	.0024	.0020	.0030	.0028	.0021	.0020	.0015	–	.0012	–
Rb ppm	–	–	–	–	–	–	–	–	–	nf	9	1	3	–
Sr %	.0025	.0055	.0074	.036	tr	nf	.032	.011	nf	.0036	nf	–	nf	–
Ba %	–	–	–	–	–	–	–	–	–	.0051	.0009	–	.0009	–
Zr %	–	–	–	–	–	–	–	–	–	.0024	.0064	–	.019	–
B ppm	16	tr	tr	tr	nf	nf	nf	11	nf		tr	–	tr	–
Zn ppm	67	57	64	70	72	69	65	63	61	100	69	–	58	–
Pb ppm	tr	tr	tr	tr	tr	tr	tr	tr	tr	2	tr	–	tr	–
Ag ppm	tr	0.6	tr	tr	tr	tr	.094	tr	tr		tr	–	tr	–
Li ppm	–	–	–	–	–	–	–	–	–	9	5	7	9	–
Magnetite	–	–	–	nf	6.6%	–	–	–	–	–	–	–	–	–

Table 5 (cont.)

5-1[1]; 73-47-86[2]; 2-208C[3]; 553000[4], 7398800[5]; Clotted metakomatiite schist with olivine, serpentine and opaque spots set in an intergrown chlorite, tremolite and opaque matrix.

5-2; 73-47-100; 2-205A; 553000, 739800; Coarse grained spotted metakomatiite schist with serpentine-olivine-opaque spots set in an intergrown tremolite, chlorite, talc matrix. Possibly part of cumulate layer?

5-3; 73-47-102; 2-201A; 551240; 7398497; Speckled metakomatiite schist with serpentine opaque and olivine specks set in an intergrown tremolite, chlorite, opaque matrix veined by tremolite, veined by serpentine, veined by carbonate.

5-4; 73-47-61; 2-208D; 553000, 7398800; Metakomatiite schist of intergrown chlorite, tremolite, and opaques.

5-5; 73-47-90; 2-201C; 551240, 7398497; Metakomatiite schist with intergrown tremolite, chlorite, serpentine and opaques and cut by serpentine veins.

5-6; 73-47-113; 2-210A; 553790, 7400070; Metakomatiite schist with chlorite, tremolite, olivine-serpentine, opaques intergrown and cut by olivine veins.

5-7; 73-47-99; 2-203C; 552000, 7398570; Sheared spotted metakomatiite schist with olivine-serpentines-opaques, chlorite, talc and rare tremolite cut by chlorite veins.

5-8; 73-47-67; 2-169; 576500, 7411250; Spotted metakomatiite schist with spots of serpentine and opaques set in intergrown chlorite, tremolite, opaque matrix.

5-9; 73-47-52; 2-183B; 578550, 7414490; Spotted metakomatiite schist with spots of magnetite and twinned clinoamphibole and serpentine set in an intergrown chlorites, tremolite, opaques matrix.

5-10; 73-47-64; 2-130; 548500, 7397500; Sheared metakomatiite schist with chlorite, tremolite and opaques.

5-11; 73-47-114; 2-176A; 577380, 7413260; Clotted metakomatiite with olivine porphyroblasts set in chlorites, tremolite, talc and opaque matrix.

5-12; 73-47-111; 2-147D; 547930, 7396750; Spotted metakomatiite with spots of opaque set in chlorites, tremolite and opaques intergrown as matrix.

5-13; 73-47-62; 2-163A; 577000, 7412670; Foliated spotted metakomatiite schist of chlorite, tremolite, anthophyllite(?) and opaques.

5-14; 73-47-76; 2-120F; 551200, 7398250; Metakomatiite schist with chlorites, tremolite and opaques intergrown. Apparently tremolite grew at two separate times and was sheared after the last.

5-15; 73-47-51; 2-150A; 564995, 7405380; Metakomatiite schist with intergrown chlorites, tremolite, olivine-serpentine and opaques.

5-16; 73-47-116; 2-162A; 577000, 741250; Sheared metakomatiite schist with sheared and kinked olivine-serpentine opaque spots set in a matrix of tremolite, chlorite, anthophyllite(?) and opaques and degraded along shear surfaces to "iddingsite".

5-17; 73-47-103; 2-174; 576100, 7411980; Metakomatiite schist with chlorites, tremolite, serpentine and opaques intergrown.

5-18; 73-47-98; 2-150B; 564995, 7405380; Metakomatiite schist with zoned tremolite, chlorites, opaques intergrown with each other and speckled by carbonate.

5-19; 73-47-93; 2-148B; 563100, 7406000; Dark, fine grained, equigranular rock composed of chlorite, tremolite, opaques, olivine and serpentine.

5-20; 73-47-85; 2-208A; 553000, 7357600; Metakomatiite schist with chlorite, tremolite, talc and opaques and spotted with phlogopite.

5-21; 73-47-54; 2-178A; 574080, 7413595; Metakomatiite schist with chlorites, tremolites, talc and opaques.

5-22; 73-47-71; 2-120K; 551200, 7398250; Metakomatiite schist with zoned tremolite, tufted chlorites and opaques.

5-23; 73-47-63; 2-70; 541500, 7412550; Metakomatiite schist with chlorites, zoned tremolite, twinned clinoamphibole and opaques.

5-24; 73-47-59; 2-204; 552170, 7398650; Metakomatiite schists with chlorites, strained tremolites, talc, opaques with rare phlogopite and a degraded amphibole (anthophyllite?).

5-25; 66-76-43; 3-506; 537680, 7395480; Metakomatiite schist with rare, degraded, orthoamphibole needles set in chlorite, antigonite, tremolite schist (SG = 2.98).

5-26; 74-21-173; 3-4009; 547500, 7410000. Spotted metakomatiite schist with olivine-serpentine and phlogopite talc set in chlorite, tremolite, opaque matrix.

5-27; 74-21-174; 3-4010; 547500, 7410000. Spotted metakomatiite schist composed mainly of olivine replaced by serpentine and with regions of chlorite, tremolite, phlogopite and by streaks of magnetite.

5-28; 74-21-175; 3-4011; 547500, 7410000. Mottled metakomatiite schist with olivine, serpentine set in tremolite, chlorite, talc, phlogopite and opaques.

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(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 6. Carbonated ultramafic rocks of the Prince Albert Group

	1	2	3	4	5*	6
Major Elements %						
SiO_2	40.30	38.70	39.00	38.90	48.30	40.10
TiO_2	.30	.29	.15	.09	.39	.28
Al_2O_3	8.00	5.90	2.20	1.90	6.20	5.80
Fe_2O_3	1.80	3.30	2.60	3.60	.80	1.30
FeO	8.00	7.70	7.10	4.00	9.60	6.10
MnO	.22	.23	.24	.23	.18	.17
MgO	25.50	28.70	27.70	26.50	23.20	27.20
CaO	7.30	5.10	2.30	11.80	6.34	6.20
Na_2O	.29	.07	.05	.07	.10	.20
K_2O	.02	.02	.01	.02	.09	.02
P_2O_5	.04	.04	.03	.03	.05	.03
CO_2	1.30	1.90	13.00	7.30	2.20	6.30
H_2O	6.70	6.80	5.00	5.70	1.10	6.50
S	.05	.07	.04	.10	.09	.06
Minor Elements						
Co %	.0084	.0085	.0094	.0074	.0075	.0079
Ni %	.12	.15	.099	.10	.078	.13
Cu %	.0035	.0033	.0036	.0032	tr	.0052
Cr %	.24	.22	.41	.25	.18	.27
V %	.020	.015	.010	.017	.008	.018
Sc %	.0027	.0031	.0013	.0029	.0018	.0019
B ppm	nf	.7	nf	tr	nf	6
Zn ppm	66	79	80	32	nf	61
Pb ppm	tr	tr	tr	5.2	tr	tr
Ag ppm	tr	tr	tr	.055	.005	tr
Sr %	0049	.0072	.0024	.036	.0053	.0043

*(Li:4, Rb:0, in ppm)

6-1[(1)]; 73-47-107[(2)]; 2-120G[(3)]; 551200[(4)], 7398250[(5)]; Metakomatiite schist with carbonate porphyroblasts in chlorite, tremolite, carbonate, opaque and pyrite matrix.

6-2; 73-47-75; 2-147A; 547930, 7396750; Spotted metakomatiite schist with olivine-serpentine-opaque set in chlorite, tremolite, opaques and carbonate matrix.

6-3; 73-47-68; 2-215B; 487920; 7357580; Spotted metakomatiite schist with talc and opaque or siderite spots set in chlorite(s), carbonate matrix.

6-4; 73-47-94; 2-120C; 551200, 739250; Metasedimentary rock with fragments of komatiite set in carbonate matrix. The metakomatiite fragments are now shredded serpentine, chlorite, tremolite, opaque intergrowths with irregular outline.

6-5; 72-76-18; 3-083; 514330, 7386450; Calcareous, fine grained hornfels with tremolite, chlorite and opaques.

6-6; 73-43-49; 2-147A; 547930, 7396750; Spotted metakomatiite schist with olivine-serpentine set in chlorite, tremolite, carbonate and opaque matrix.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 7. Chemical analyses of potassic ultramafic rocks of the Prince Albert Group

	1	2	3	4
Major Elements %				
SiO_2	41.20	41.63	40.88	43.35
TiO_2	.07	.06	.06	.05
Al_2O_3	1.97	1.06	.69	.41
Fe_2O_3	1.68	1.15	1.59	1.23
FeO	4.50	5.10	5.10	4.40
MnO	.24	.24	.27	.17
MgO	41.46	41.94	42.40	39.84
CaO	.02	.03	.07	.06
Na_2O	.00	.03	.00	.01
K_2O	1.56	.76	.38	.16
P_2O_5	.03	.04	.03	.02
CO_2	.00	.00	.00	.00
H_2O	7.40	8.00	8.50	9.60
S	.11	.11	.13	.19
Minor Elements				
Co %	.0085	.0083	.0091	.010
Ni %	.22	.23	.21	.26
Cu %	.0098	.00058	.0010	.0023
Cr %	.14	.13	.13	.25
V %	.0021	.0026	.0025	.0036
Sc %	.0056	.00077	.00078	.00054
Rb ppm	222	117	61	25
Sr %	nf	.0017	.0015	.0014
Ba %	.0036	.0023	.0015	.0013
Zr %	tr	tr	tr	tr
B ppm	tr	tr	15	30
Zn ppm	71	82	96	98
Pb ppm	tr	tr	tr	tr
Ag ppm	tr	tr	tr	tr
Cl %	.03	.02	.03	.01
F %	.08	.07	.06	.08
Li ppm	6	3	3	3

7-1[(1)]; 74-21-197[(2)]; 3-4033[(3)]; 550140[(4)], 7406730[(5)]; Schist with biotite(s) and olivine set in chlorite, serpentine, talc, opaque matrix.

7-2; 74-21-198; 3-4034; 550140, 7406730; Schist with anastomosing olivine grains and biotites set in chlorite, serpentine, talc opaque matrix.

7-3; 74-21-199; 3-4035; 550140, 7406730; Schist with irregular shaped olivine grains and phlogopite set in chlorite, serpentine and opaque matrix.

7-4; 74-21-200; 3-4036; 550140, 7406730; Schist with olivine replaced by serpentine and opaques and rare chlorite and talc.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTM (all UTM's in zone 15W)

N.B. The reader is also referred to Schau (1975) for pictures and mineral analyses of a biotite-tremolite-chlorite rock.

Table 8. Chemical analyses of quartzites of the Prince Albert Group

	1	2	3	4	5	6	7	8	9	10	11
Major Elements %											
SiO_2	97.50	99.40	98.1	96.70	96.8	97.5	90.0	91.7	90.2	90.2	77.0
TiO_2	.02	.01	.01	.02	.03	.03	.17	.12	.16	.24	.08
Al_2O_3	.18	.68	.76	1.20	1.63	1.7	5.59	3.68	6.36	7.89	3.40
Fe_2O_3	.00	.00	.00	.10	.10	.10	.20	.20	.5	.1	.6
FeO	.66	.20	.80	.43	.85	.33	.29	.62	.47	.27	.43
MnO	.02	.01	.02	.00	.02	.00	.00	.01	.00	.01	.04
MgO	.05	.01	.19	.06	.32	.02	.07	.17	.42	.09	.54
CaO	.15	.04	.04	.04	.06	.04	.06	.07	.05	.05	10.6
Na_2O	.00	.00	.00	.00	.3	.00	.10	.30	.2	.2	.9
K_2O	.02	.06	.06	.25	.34	.46	1.52	.93	1.69	.78	.26
P_2O_5	.03	.02	.01	.02	.03	.03	.02	.03	.05	.02	.08
CO_2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	6.9
H_2O_T	.00	.00	.00	.20	.40	.20	.70	1.0	.9	.7	.1
S	.00	.00	.00	.00	.00	.00	.00	.03	.00	.01	.00
Minor Elements											
Co %	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
Ni %	nf	nf	.0013	nf	.0019	nf	nf	nf	nf	.0026	nf
Cu %	tr	nf	tr	tr	.0013	tr	tr	.0011	.0012	tr	tr
Cr %	.20	.076	.19	.19	.24	.10	.074	.014	.035	.12	.090
V %	.0065	.0024	.0054	.0051	.0064	.0035	.0043	.0050	.0030	.0035	.0041
Sc %	nf	nf	nf	nf	tr	nf	nf	tr	nf	tr	nf
Zn ppm	58	95	nf	nf	tr	nf	50	55	33	40	69
Pb ppm	.5	.5	1	.5	3	6	12	9	4	26	4
U ppm	.2	.2	nf	.2	.2	.2	.11	.51	.02	.51	.5
Th ppm	3.	5.	nf	nf	7.	22.		21.	9.	14.	7.
Zr %	tr	tr	tr	tr	tr	tr	.002	.006	tr	.083	tr
Sr %	tr	.001	tr	tr	tr	.002	.004	tr	.006.	004.	029
Rb %	tr	tr	tr	tr	tr	tr	.003	tr	.003	.001	tr
Ba %	tr	.001	.001	.004	.002	.011	.026	.020	.012	.010	.013

8-1[1]; 43-75-460[2]; 3-250[3]; 496350[4], 7351950[5]; Quartzite with rare kyanite rimmed by muscovite and chlorite (SG = 2.62).

8-2; 43-75-455; 3-246; 495790, 7354750; Quartzite with muscovite and tourmaline.

8-3; 43-75-449; 3-444; 498140; 7345430; Quartzite with muscovite, tourmaline, chlorite and kyanite (SG = 2.64).

8-4; 43-75-452; 3-442; 499940, 7347160; Quartzite with muscovite, chlorite and a small amount of kyanite (SG = 2.64).

8-5; 43-75-456; 2-169E; 529500, 735300; Coarse grained metasandstone with anastomosing quartz grains with chlorite and grains of partly degraded plagioclase with interstitial clay, epidote, opaque and carbonate and accessory zircon and apatite.

8-6; 43-75-458; 2-161; 570180, 7408729; Sacharoidal quartzite with fine grained annealed quartz and muscovite with accessory tourmaline and rare opaques. Specimens near this locality carry andalusite.

8-7; 43-75-448; 2-155; 565000, 7406000; Crossbedded quartzite with medium grained strained polygonitized grains contain amoeboid muscovite books and rare sphene.

8-8; 43-75-447; 3-05; 552180, 7389710; Sheared quartzite with muscovite and chlorite and rounded accessory grains of opaques, sphene, zircon, apatite, allanite and hematite (SG = 2.58).

8-9; 43-75-453; 2-224B; 497000, 7347160; Quartzite with sand-size grains locally polygonitized and set in finer grained quartz, muscovite chlorite matrix with rare garnets, tourmaline and opaques.

8-10; 43-75-457; 3-283; 484100, 7363800; Muscovitic quartzite with rare kyanite, garnet, chlorite and tourmaline (SG = 2.67).

8-11; 43-45-459; 2-117D; 516050, 7380900; Quartzite with carbonate cement. Coarse grained, strained quartz grains and poikiloblastic oligoclase grains are set in carbonate and clinozoisite matrix with accessory sphene.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 9. Chemical analyses of ironrich metasedimentary rocks of the Prince Albert Group

	1	2	3	4	5	6	7	8	9	10
Major Elements %										
SiO_2	49.90	55.90	53.90	64.40	52.20	53.80	56.70	57.50	39.70	58.00
TiO_2	.18	.02	.15	.02	.69	.61	1.00	.67	.02	.19
Al_2O_3	5.50	.90	4.00	.50	10.00	8.90	11.50	10.90	.78	4.80
Fe_2O_3	19.80	6.40	19.60	7.30	9.20	9.10	4.30	2.20	36.10	7.00
FeO	18.10	29.00	16.60	21.60	13.30	11.60	12.30	10.00	18.00	19.20
MnO	.07	.51	.05	1.30	.57	.51	.37	.29	0.05	.11
MgO	1.60	3.69	1.39	1.89	5.20	4.68	3.70	6.90	1.90	2.10
CaO	2.94	1.02	.98	.22	.20	4.15	1.50	8.65	3.00	4.40
Na_2O	.40	.04	.60	.00	.04	.60	.13	1.30	.05	.55
K_2O	.18	.04	1.38	.09	.20	.13	1.70	.26	.05	.33
P_2O_5	.42	.32	.39	.05	.03	.06	.04	.07	.24	.30
CO_2	.00	.20	.00	.00	.00	.00	.00	.00	.00	.00
H_2O	1.30	2.60	.60	1.60	5.10	3.50	5.10	1.30	.05	1.90
S	.17	.01	.00	.29	1.90	1.10	.05	.00	.04	.34
Minor Elements										
Co %	.0044	.0043	.0049	.0044	.0074	.0098	.014	.014	nf	nf
Ni %	.0075	.0059	.0072	.0046	.10	.096	.14	.10	nf	tr
Cu %	.0013	.0033	.0020	.0012	.0058	.0077	tr	.0086	tr	tr
Cr %	.0099	.0062	.0087	.0049	.34	.38	.42	.28	tr	tr
V %	tr	tr	tr	tr	.025	.012	.028	.019	tr	.0044
Sc %	tr	tr	tr	nf	.037	.0022	.0031	.0025	nf	nf
Sr %	.0037	.0015	.010	.015	nf	.0067	.027	.0038	.0035	tr
Ba %	.0022	.0027	.027	.015	.0038	.0027	.0640	.011	.0017	.011
B ppm	–	–	–	–	tr	–	100	–	tr	nf
Zn ppm	–	–	–	–	600+	–	210	–	46	70
Pb ppm	–	–	–	–	64	–	8	–	1	1
Ag ppm	–	–	–	–	2.1	–	.1	–	.053	tr
Zr %	.011	.0088	.0110	.089	–	.0064	–	.0075	–	–
Li ppm	11	1	1	2	–	41	–	25	–	–
Rb ppm	2	2	2	1	–	4	–	8	–	–
C %	–	–	–	–	.04	–	.11	–	–	–

9-1[1]; 72-76-22[2]; 3-264[3]; 484500[4], 7360100[5]; Silicate iron formation with layers of garnet, iron amphiboles, magnetite and quartz (SG = 3.21) (Y = .0056%).

9-2; 72-76-21; 3-85A; 514480, 7386250; Silicate iron formation with sulphide streaks, chlorite, iron amphiboles, magnetite and quartz (SG = 2.90) (Y = .0071, Ce = .025).

9-3; 72-76-5; 3-265; 484130, 7359800; Silicate iron formation with layers of biotite, garnet, iron amphiboles, magnetite and quartz (SG = 3.17) (Y = .0068).

9-4; 72-76-11; 3-253; 493600, 7355120; Pyritic silicate iron formation with iron amphiboles, garnet, magnetite, pyrite and quartz (SG = 2.96) (Y = .0049).

9-5; 73-47-66; 2-227E; 487430, 7358200; Garnetiferous chloritic phyllite with chlorite, biotite, and quartz layers, as well as interbedded magnetite and poikiloblastic garnet layers.

9-6; 72-76-12; 3-83A; 514330, 7386450; Silicate iron formation with chlorite, iron amphiboles, magnetite and quartz (SG = 2.89) (Y = .0044).

9-7; 73-47-77; 2-221C; 487550, 7358408; Silicate iron formation with garnet layers set in amphibole matrix with biotite (2.3% magnetite).

9-8; 72-76-6; 3-83B; 514330, 7386450; Silicate iron formation with chlorite, iron amphiboles, magnetite, and quartz (SG = 2.91) (Y = .0041).

9-9; 73-47-106; 2-152B; 565850, 7404990; Oxide iron formation with fine grained quartz layers, magnetite with hornblende layers, with accessory apatite and tourmaline (50% magnetite).

9-10; 73-47-56; 2-175A; 577750, 7412995; Oxide silicate iron formation with well folded lamellae of quartz magnetite and iron amphiboles with scattered pyrite.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 9 (cont.)

	11	12	13	14	15	16	17	18	19	20
Major Elements %										
SiO_2	43.20	44.90	54.20	41.50	49.90	54.30	37.10	41.40	38.80	37.30
TiO_2	.68	.67	.68	.92	.45	.56	.58	.52	.54	.37
Al_2O_3	11.80	13.00	7.60	13.30	6.60	12.20	6.70	7.30	6.90	4.70
Fe_2O_3	7.20	6.20	4.50	4.50	3.70	3.40	12.80	5.00	6.50	13.00
FeO	18.80	15.80	15.40	15.20	14.70	14.60	13.90	17.60	14.70	17.20
MnO	1.40	.86	.95	.46	.92	.78	.63	.51	.38	.41
MgO	3.20	2.80	6.60	10.90	3.30	2.60	8.60	10.60	8.80	8.50
CaO	7.70	8.20	5.50	6.00	12.00	6.00	10.70	12.00	15.90	14.30
Na_2O	.83	1.70	.23	.85	.87	3.10	1.50	1.00	1.50	.54
K_2O	1.20	1.60	.25	.13	.22	.68	.17	.61	.20	.35
P_2O_5	.16	.14	.07	.06	.05	.13	.06	.02	.06	.05
CO_2	.65	1.10	.59	.00	5.20	.39	.00	.00	2.40	.59
H_2O	2.20	2.10	2.20	4.60	1.50	1.30	3.30	1.70	2.30	1.20
S	.46	.36	.19	.23	1.7	.21	3.00	.97	.66	1.50
Minor Elements										
Co %	tr	nf	.013	.015	.011	nf	.0094	.011	.015	.013
Ni %	.0017	.0016	.15	.21	.12	.0012	.082	.15	.13	.11
Cu %	.0024	.0027	.0080	.0092	.0039	.0007	.16	.059	.47	.12
Cr %	.0013	tr	.31	.65	.27	.0010	.41	.32	.25	.20
V %	.013	.014	.024	.047	.023	.017	.021	.022	.025	.018
Sc %	.0014	.0010	.030	.0053	.0018	.0012	.0025	.0029	.0032	.0021
Sr %	.0101	.019	.0074	.0039	.015	.019	.0063	.019	.0056	.0011
Ba %	.025	.030	.0068	.0021	.034	.016	.0033	.015	.0024	.0076
B ppm	tr	tr	tr	nf	nf	nf	nf	nf	nf	nf
Zn ppm	61	59	250	120	68	84	61	100	68	66
Pb ppm	3	5	8	1	1	tr	4	1	2	1
Ag ppm	.067	.075	.24	.055	tr	.069	1.2	.14	3	.3
Zr %	.022	.024	.0072	.010	tr	.021	.0071	.0084	tr	.0083
Li ppm	–	–	–	–	–	–	–	–	–	–
Rb ppm	–	–	–	–	–	–	–	–	–	–
C %	.08	–	–	–	–	–	–	–	–	–

9-11; 73-47-83; 2-220C; 487770, 7358270; Garnetiferous amphibolite with layers of garnet and quartzofeldspathic "fragments" set in hornblende, actinolite, chlorite, opaque and carbonate matrix (no magnetite found).

9-12; 73-47-53; 2-220C; 487770, 7358270; Garnetiferous amphibolite with flattened "clasts" of quartzofeldspathic material and amphibole-chlorite fragments set in folded silty matrix of helicitic garnet, hornblende, actinolite, biotite, opaque and carbonate matrix.

9-13; 73-47-89; 2-221E; 487550, 7358408; Calcareous fine grained amphibolite (2.3% magnetite).

9-14; 73-47-84; 2-228B; 487400, 7357600; Fragmental amphibolite with fragments of quartz or chert mosaics set in layers of varying proportions of hornblende and actinolite (garbenschiefer texture).

9-15; 73-47-58; 2-222A; 487300, 7358700; Dark foliated, layered amphibolite with layers of carbonate, quartz and chert mosaic set in biotite, hornblende, actinolite, opaque and carbonate matrix with apatite and hematite.

9-16; 73-47-73; 2-220B; 487770, 7358270; Garnetiferous amphibolite with flattened quartzofeldspathic or quartz mosaic "regions" and layers of biotite and helicitic garnet set in amphibole, opaques, and carbonate matrix with apatite, zircon and amphibole rosettes (garbenschiefer textures) (.3% magnetite).

9-17; 73-47-112; 2-200; 551040, 7398450; Sulphide, silicate iron formation with actinolite, magnetite and pyrite layers cut by calcite, ankerite and chlorite veins (2.4% magnetite).

9-18; 73-47-50; 2-150D; 564995, 7405380; Silicate iron formation with magnetite layers in fine grained hornblende.

9-19; 73-47-105; 2-217E; 487960, 7357800; Amphibolite with actinolite with carbonate matrix and calcite chalcopyrite veins (magnetite not found).

9-20; 73-47-88; 2-150c; 564995, 7405380; Sulphide silicate iron formation with magnetite and pyrite layers in chlorite, hornblende, clinopyroxene, garnet and carbonate matrix (36.5% magnetite).

Table 10. Chemical analyses of pelites of the Prince Albert Group

	1	2	3	4	5	6	7	8	9	10	11
Major Elements %											
SiO_2	78.00	83.60	80.00	73.70	70.85	70.97	70.36	72.40	63.80	71.10	62.00
TiO_2	.37	.42	.42	.24	.46	.47	.48	.36	.22	.76	.61
Al_2O_3	7.00	12.40	11.20	6.80	13.32	13.38	13.25	11.00	7.40	18.50	16.30
Fe_2O_3	1.60	.20	.76	2.50	0.00	.21	.00	.80	2.50	.40	3.40
FeO	4.70	.20	3.20	8.70	3.80	3.40	4.00	7.70	5.80	3.00	8.90
MnO	.06	.00	.07	.02	.06	.07	.08	.02	00.11	.02	.12
MgO	3.80	.24	.38	1.90	1.93	1.84	1.91	1.90	13.60	1.54	2.10
CaO	.28	.08	.34	.47	2.76	2.40	2.55	.19	.23	.19	.22
Na_2O	1.10	.20	.34	.52	3.58	3.30	3.33	.10	.05	.30	.21
K_2O	.50	1.70	1.60	3.30	2.40	2.97	2.78	2.33	.05	3.03	1.60
P_2O_5	.16	.03	.31	.14	.17	.17	.17	.15	.07	.14	.16
CO_2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
H_2O	2.70	.90	1.60	1.50	.80	.60	.90	3.10	5.20	2.00	3.50
S	.01	.08	.03	.04	.08	.01	.05	.31	.03	.11	.13
Minor Elements											
Co %	.0023	tr	tr	nf	tr	tr	tr	.0020	.0039	tr	nf
Ni %	.036	tr	.0056	nf	.0022	.0018	.0012	.0061	.10	nf	.013
Cu %	tr	.0007	tr	tr	.0069	.0015	.0009	.0031	tr	.0120	.0017
Cr %	.043	.016	.0072	.0017	.0079	.0077	.0008	.010	.016	.016	.016
V %	.0082	.0037	.011	.0030	.010	.010	.0094	.0029	.0086	.0064	.013
Sc %	.0009	tr	.0011	nf	.0008	.0009	.0008	.008	.0010	.0014	.0028
Sr %	nf	.0062	.044	.0046	.037	.030	.036	.0057	nf	.0140	.0093
Ba %	.0021	.060	.10	.039	.077	.083	.096	.058	.031	.073	.074
B ppm	.20		190	nf	nf	nf	nf	150	7	148	100
Zn ppm	45	tr	41	47	51	56	58	77	68	36	210
Pb ppm	5	7	7	7	18	21	18	5	1	20	8
Ag ppm	.12		tr	.055	.058	tr	.057		.18		.1
Zr %	.026	.022	.010	.014	.023	.025	.029	.0098	.045	.029	–
Li ppm	–	5	–	–	33	32	37	20	–	41	–
Rb ppm	–	54	–	–	116	122	122	93	–	132	–
C %	–	–	.35	.05	–	–	–	–	–	–	.12
U ppm	–	–	–	–	–	–	–	–	–	–	–
Th ppm	–	–	–	–	–	–	–	–	–	–	–

	12	13	14	15	16	17	18	19	20	21	22
Major Elements %											
SiO_2	71.30	62.00	63.80	60.70	61.20	53.40	59.90	52.00	72.2	86.7	73.9
TiO_2	.26	.78	.68	.98	.97	.69	.64	.65	.29	.22	.53
Al_2O_3	16.60	21.80	21.30	16.70	22.00	15.10	26.10	29.90	14.6	9.9	14.6
Fe_2O_3	.80	.70	1.00	2.00	.60	2.40	.30	.60	.3	.2	2.2
FeO	1.20	3.30	1.80	4.80	3.70	6.70	2.10	2.70	1.7	.75	.86
MnO	.02	.03	.01	.09	.07	.41	.00	.00	.05	.02	.09
MgO	1.02	2.55	1.64	2.67	2.29	2.10	1.84	1.64	.60	.09	1.16
CaO	1.45	.22	.19	4.01	1.58	7.30	.20	.14	2.92	.05	.25
Na_2O	2.90	.90	1.40	3.30	2.10	3.10	1.10	1.20	4.3	.3	.2
K_2O	2.35	3.74	4.16	2.66	2.90	3.10	4.87	7.82	1.66	1.50	1.11
P_2O_5	.18	.07	.09	.23	.19	.22	.11	.09	.08	.03	.17
CO_2	.00	.00	.00	.00	.00	3.20	.00	.00	.3	.00	.00
H_2O	1.80	3.80	3.40	1.60	2.00	1.70	2.50	3.40	.5	.7	2.1
S	.04	.00	.20	.08	.15	.06	.10	.00	.00	.03	.89
Minor Elements											
Co %	nf	.0010	tr	.0016	.0024	tr	tr	tr	nf	nf	nf
Ni %	.0027	.0047	.0016	.0065	.0092	.0024	.0039	.0038	.0014	.0015	tr
Cu %	.0016	.0053	.003	.0023	.0073	.0015	.0037	.0015	tr	.0014	.011
Cr %	.0055	.025	.026	.021	.021	.0016	.022	.022	.13	.30	.074
V %	.0044	.012	.013	.0099	.014	.014	.016	.019	.0069	.0094	.0083
Sc %	.0037	.0014	.0013	.0015	.0014	.0014	.0016	.0014	nf	tr	.0009
Sr %	.031	.028	.026	.027	.028	.020	.019	.012	.048	.002	.001
Ba %	.030	.075	.093	.056	.065	.039	.110	.16	.027	.036	.042
B ppm	100	180	160	tr	560	tr	tr	tr	–	–	–
Zn ppm	83	68	29	52	15	36	14	30	37	49	250
Pb ppm	24	15	20	3	9	11	8	12	5	5	16
Ag ppm	nf	nf	nf	nf	nf	tr	–	nf	–	–	–
Zr %	.010	.014	.012	.020	.016	.013	.011	.018	.002	.002	.007
Li ppm	55	50	32	40	–	–	22	30	–	–	–
Rb ppm	53	124	128	114	–	–	110	168	.004	.002	.006
C %	–	–	–	–	–	.13	–	–	–	–	–
U ppm	–	–	–	–	–	–	–	–	.2	1.5	.6
Th ppm	–	–	–	–	–	–	–	–	11.	14.	2

Table 10 (cont.)

10-1[1]; 73-47-97[2]; 2-120B[3]; 551200[4], 7398250[5]; Layered quartzofeldspathic schist with fragments of quartz "aggregates" set in a silty quartzose chloritic and biotitic matrix with layers of apatite and zircon in layers and accessory opaques, sphene, tourmaline, and allanite. Possibly a basal conglomerobreccia?

10-2; 76-72-16; 3-254; 491700, 7353570; Quartzose muscovite schist with sparing amounts of chlorite, sheared and bent kyanite, chromian muscovite and sphene, allanite, pyrite and rarely, small red garnets (SG = 2.70).

10-3; 73-47-60; 2-227C; 487430, 7358200; Phyllite with kyanite laths in microfolded muscovite, quartz, opaque matrix.

10-4; 74-47-82; 2-223B; 486550, 7358300; Metasiltstone or fine grained biotite schist composed of biotite, quartz and quartzofeldspathic matrix with accessory apatite.

10-5; 74-21-201; 3-4037; 552440, 7402330; Meta-arenite or siliceous biotite schist composed of quartz, quartzofeldspathic mosaic, poikiloblastic plagioclase and biotite with sphene and epidote, and accessory zircon, apatite and allanite.

10-6; 74-21-202; 3-4038; 552440, 7402330; Meta-arenite or siliceous biotite schist with quartz, quartzofeldspathic mosaic, poikiloblastic plagioclase and biotite with sphene and epidote in varying proportions to form layered aspect. Accessory zircon, apatite and allanite.

10-7; 74-21-203; 3-4039; 552440, 7402330; Meta-arenite with quartz, quartzofeldspathic mosaic, poikiloblastic plagioclase and biotite with sphene and epidote as well as zircon, apatite and allanite as accessories.

10-8; 76-72-23; 3-87D; 514330, 7396940; Pyritic fine grained micaschist with quartz, muscovite, chlorite, biotite and scattered pyrite (SG = 2.72).

10-9; 73-47-87; 2-120A; 551200, 7398250; Fine grained metasiltstone composed of quartz, relict plagioclase, chlorite, chlorite pseudomorphic after amphibole, and opaques with accessory zircon.

10-10; 76-66-44; 2-160; 573150, 7408800; Porphyroblastic biotite schist with andalusite and cordierite set in a finer grained matrix of quartz, muscovite, staurolite, and accessory apatite, zircon and tourmaline.

10-11; 73-43-78; 2-227D; 487430, 7355820; Complexly folded and kinked phyllite or chlorite schist with chloritoid laths and small garnets set in white mica, chlorite, quartz and opaque matrix.

10-12; 76-22-20; 3-280; 48352, 7367400; Staurolite schist with two micas, quartz, altered feldspars, and opaques; includes hematite (SG = 2.61).

10-13; 76-72-14; 3-234B; 486000, 7357100; Lineated two mica phyllite with accessory sphene and hematite (SG = 2.73).

10-14; 76-72-17; 3-270; 483300, 7357680; Porphyroblastic two mica phyllite with spots of biotite (SG = 2.70).

10-15; 76-72-15; 3-132; 523490, 7368100; Quartzose biotite schist (SG = 2.68).

10-16; 76-72-13; 3-129; 532570, 7391280; Garnetiferous two mica schist with altered alkali feldspars, chloritized biotite, white mica with tourmaline, apatite and zircon accessories (SG = 2.75). Also seen on spec: Yb = .0004, Y = .0043, La = .010, Ce = .020, Be = .0004.

10-17; 73-43-96; 2-220D; 487770, 7358270; Vaguely layered metasiltstone with quartz, chlorite, biotite, muscovite, carbonate matrix and garnet porphyroblasts and accessory apatite and tourmaline.

10-18; 76-66-45; 2-119; 550740, 7399580; Porphyroblastic schist with poikiloblastic andalusite and cordierite, and biotite books set in locally chloritized biotite, white mica, and quartzofeldspathic matrix with accessory zircon, apatite, sphene, tourmaline and opaques.

10-19; 76-72-7; 3-411; 541350, 7419300; Layered porphyroblastic two mica schist with spots of biotite set in plagioclase, garnet and magnetite, white mica and biotite with zircon and allanite as accessories.

10-20; 46-75-450; 2-152A; 566440, 7404760; Metasandstone (arkose?) with rounded quartz grains; schistose and partly recrystallized poikilitic or annealed quartz, plagioclase, and K-feldspar matrix with muscovite, biotite, garnet and late porphyroblastic chlorites, as well as opaques, carbonate, clinozoisite, sphene and apatite as minor phases.

10-21; 46-75-451; 3-254; 491700, 7353570; See 10-2, quartz-rich metasandstone with recrystallized quartz and rare muscovite and chromian muscovite, as well as rare chlorite with fine grained opaques (after biotite?) and bent kyanite as well as sphene and allanite.

10-22; 46-75-454; 3-395C; 546580, 7419340; Pyritic muscovite schist with muscovite , biotite, chlorite, quartz matrix with cordierite, garnet and accessory zircon, apatite, allanite, sphene and opaques.

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(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 11. Chemical analyses of assorted pelites of the Prince Albert Group

	1	2	3	4	5
Major Elements %					
SiO_2	60.80	43.40	51.20	37.60	44.30
TiO_2	.65	.33	1.30	.58	.60
Al_2O_3	16.50	7.40	12.80	9.10	9.50
Fe_2O_3	1.30	1.60	2.90	2.90	2.60
FeO	4.90	8.50	10.90	9.80	9.40
MnO	.10	.18	.20	.27	.20
MgO	2.10	26.50	6.10	7.70	17.20
CaO	5.40	5.30	9.40	18.80	7.20
Na_2O	6.80	.06	.32	.97	.90
K_2O	.21	.01	3.60	.19	4.20
P_2O_5	.21	.08	.15	.07	.08
CO_2	.00	.00	.00	8.30	.00
H_2O	.30	6.30	1.20	2.40	3.30
S	.38	.03	.08	.07	.00
Minor Elements					
Co %	nf	.0063	.0024	.011	.0064
Ni %	.0008	.0073	.0015	.0047	.043
Cu %	.0041	.0013	.0033	.016	tr
Cr %	.0020	.23	tr	.43	.21
V %	.015	.019	.051	.038	.026
Sc %	.0010	.0024	.0048	.0031	.0036
Sr %	.032	nf	.023	.0088	.0043
Ba %	.0070	tr	.0070	.0039	.036
B ppm	nf	nf	nf	nf	nf
Zn ppm	70	84	94	71	57
Pb ppm	4	tr	tr	tr	tr
Ag ppm	.067	tr	.065	.078	tr
Zr %	.016	tr	.014	tr	tr

11-1[1]; 73-47-55[2]; 2-202B[3]; 551570[4], 7398600[5]; Pyritic quartz arenite; poorly sorted quartz, plagioclase, brown biotite, actinolite, opaques, zircon and apatite.

11-2; 73-47-118; 2-227D; 487430, 7358200; Chloritic phyllite; fine grained aggregate of quartz, chlorite, white mica, chloritoid and opaques with folded quartz veins. (see Table 4).

11-3; 73-47-70; 2-203A; 552000, 7398570; Hornfels; fine grained quartz, plagioclase, hornblende, opaques, apatite and hematite.

11-4; 73-47-57; 2-222B; 487300, 7358700; Layered amphibolite and chert carbonate; quartz plagioclase layers with iron amphiboles, hornblende, actinolite and chlorite, as well as opaques and carbonate in matrix. (see Table 4).

11-5; 73-47-101; 2-208G; 553000, 739880; Fine grained, sulphide-bearing "hornfels" with quartz, chlorite blebs in biotite, hornblende, chlorite, opaque matrix.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 12. Potassium-argon dates from 56J and K

K-Ar No.	Mineral	Rock Type	Unit	K%	Rad. Ar%	Date (Ma)
1. 2397	Tourmaline	granite	Agr*	.069	91.2	1800 ± 116
2. 2415	Whole rock	metagabbro	Ad	.610	96.0	1613 ± 48
3. 2413	Hornblende	metagabbro	Ad	.196	96.6	1891 ± 120
4. 2400	Muscovite	granite	Agrm	8.47	98.7	1735 ± 44
5. 2398	Tourmaline	contact with 2400	APk	.067	92.0	2342 ± 470
6. 2414	Biotite	contact with 2400	APk	7.53	99.6	1683 ± 42
7. 2412	Hornblende	metagabbro in	AWgn	.338	97.7	2223 ± 58
8. 2411	Biotite	metagabbro in	AWgn	6.27	99.2	1605 ± 39
9. 61-94	Biotite	basic schist in	AWgn	8.20	100.0	1700
10. 2425	Biotite	metakomatiite schist	APk	6.37	99.5	1593 ± 39
11. 2426	Amphibole	metakomatiite schist	APk	.202	94.1	1828 ± 116
12. 2427	Whole rock	metakomatiite schist	APk	2.87	98.9	1633 ± 79
2425-2427	"Isochron"					1575**

* Contact rock to this pluton has Rb-Sr isochron 1679 ± 26 Ma ($^{87}Sr/^{86}Sr_{(in)}$ = .8260)

** Excess argon ($^{40}Ar/^{36}Ar_{in}$ = 1446).

1. 3-5149; 553050[(1)], 7411500;
2. 2-080; 550400, 7403450;
3. 2-080; 550400, 7403450;
4. 2-037; 545840, 7408420;
5. 3-3003A; 534500, 7397400;
6. 2-026; 546930, 7409950;
7. 2-083; 551080, 7403850;
8. 2-083; 551080, 7403850;
9. AC 115-60; 66°49'N 91°48'W;
10. 3-126; 528200, 7383000;
11. 3-126; 528200, 7383000;
12. 3-126; 528200, 7383000;

(1) all localities in Zone 15 W

Table 13. Chemical analyses of metagabbroic rocks

	1	2	3	4	5	6	7	8
Major Elements %								
SiO_2	45.70	44.62	44.18	45.12	45.73	45.03	52.70	50.50
TiO_2	.63	1.63	1.67	1.36	1.56	1.60	1.60	.18
Al_2O_3	9.10	12.35	11.85	13.88	11.86	11.12	15.10	13.10
Fe_2O_3	1.40	5.75	5.71	5.40	5.46	5.57	4.40	.35
FeO	13.90	12.70	12.70	11.10	11.40	11.20	6.40	4.30
MnO	.31	.29	.29	.22	.24	.25	.16	.11
MgO	9.00	7.19	7.42	6.29	7.11	7.87	3.90	12.70
CaO	11.30	11.21	11.83	11.20	12.29	13.13	7.00	14.80
Na_2O	.15	1.79	1.68	1.75	.96	.80	3.40	1.30
K_2O	.07	.65	.48	1.09	.89	.65	2.70	.09
P_2O_5	.05	.06	.06	.05	.06	.07	.63	.04
CO_2	2.60	.01	.01	.00	.00	.00	.00	2.10
H_2O	3.30	1.60	1.80	1.80	2.00	1.80	1.60	.60
S	1.20						.01	.08
Minor Elements								
Co %	.012	.0060	.0063	.0053	.0062	.0070	tr	.0023
Ni %	.15	.0071	.0057	.0045	.0055	.0057	.0010	.013
Cu %	.020	.0065	.0050	.015	.010	.0044	.0021	tr
Cr %	.46	tr	tr	tr	tr	tr	tr	.051
V %	.031	.12	.12	.12	.13	.13	.028	.018
Sc %	.0037	.0053	.0057	.0042	.0048	.0047	.0023	.0032
Sr %	.023	.031	.032	.041	.021	.025	.043	.022
Ba %	tr	.025	.014	.015	.012	.0083	.084	.0037
B ppm	tr	tr	tr	tr	tr	tr	nf	nf
Zn ppm	160	70	70	60	68	62	90	27
Pb ppm	15	19	17	18	19	18	15	5
Ag ppm	.54	.070	tr	tr	tr	tr	tr	.11
Zr %	tr	.0090	.0082	.0097	.0069	.0065	.049	tr
Li ppm	–	6	6	6	6	5	–	–
Rb ppm	–	17	5	13	39	26	–	–
Y %	–	–	–	–	–	–	.0057	tr
Sn ppm	–	–	–	–	–	–	9	tr
Cl %	–	.01	.01	.05	.01	.02	–	–
F %	–	.04	.04	.04	.05	.05	–	–

13-1[1]; 73-47-80[2]; 2-218A[3]; 487960[4]; 7358100[5]; Recrystallized sheared metagabbro. Labradorite and fine grained quartz and plagioclase mosaic, hornblende degraded to actinolite and chlorite and irregular oxides have been partly replaced by carbonate.

13-2; 74-21-192; 3-4028; 547670, 7409680; Actinolite schist with relict plagioclase, quartz plagioclase mosaic set in actinolite dotted with opaques.

13-3; 74-21-193; 3-4029; 547670, 7409680; Actinolite schist with relict plagioclase, quartz plagioclase mosaic set in actinolite dotted with opaques.

13-4; 74-21-193; 3-4030; 547670, 7409680; Actinolite schist with relict plagioclase, quartz plagioclase mosaic set in actinolite dotted with opaques.

13-5; 74-21-194; 3-4031; 547670, 7409680; Actinolite schist with relict plagioclase, quartz plagioclase mosaic set in actinolite dotted with opaques.

13-6; 74-21-195; 3-4032; 547670, 7409680; Actinolite schist with relict plagioclase, quartz plagioclase mosaic set in actinolite dotted with opaques.

13-7; 73-47-95; 2-105; 551050, 7400490; Amphibolite with relict plagioclase, hornblende, with abundant biotite, apatite, and opaques with sphene, speckled by epidote and carbonate.

13-8; 73-47-117; 2-181A; 578375, 7414005; Brecciated metagabbro. Fine- to medium-grained plagioclase and quartz plagioclase mosaic, hornblende, sphene and opaques and epidote is veined by carbonate.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 13 (cont.)

	9	10	11	12	13	14	15	16	17
Major Elements %									
SiO_2	48.90	54.80	40.10	49.60	55.20	48.30	47.20	46.60	51.06 ± 4.56
TiO_2	.22	1.45	.63	.65	.65	1.40	1.20	1.00	1.17 ± 1.00
Al_2O_3	15.60	12.20	17.10	12.10	15.30	10.30	7.20	12.20	15.91 ± 3.66
Fe_2O_3	.54	1.40	11.70	1.50	.90	3.40	2.60	2.50	3.10 ± 2.15
FeO	5.30	12.70	5.10	9.70	6.50	12.00	11.80	11.10	7.76 ± 3.06
MnO	.12	.20	.14	.21	.12	.22	.27	.34	.12
MgO	12.30	5.20	4.00	10.20	5.40	7.70	11.70	10.50	7.68 ± 3.48
CaO	13.60	6.40	14.90	9.70	8.70	11.40	12.70	7.60	9.88 ± 2.78
Na_2O	1.00	3.40	1.30	3.30	5.10	2.70	1.00	1.50	2.48 ± 1.17
K_2O	.15	.44	1.80	.24	.36	.36	.25	3.60	.96 ± .85
P_2O_5	.11	.29	.31	.08	.15	.13	.09	.09	.24
CO_2	.00	.00	.00	.00	.00	.00	.00	.00	.07
H_2O	1.90	1.10	2.20	1.90	.70	1.20	2.00	2.20	.86
S	.02	.02	.14	.00	.01	.00	.02	.00	–
Minor Elements									
Co %	.0024	.0026	tr	.0045	.0018	.0048	tr	.0044	–
Ni %	.013	.0021	.0023	.012	.0023	.023	.016	.011	–
Cu %	.0019	.0039	.0056	.0056	tr	.0057	tr	nf	–
Cr %	.0079	.0055	.28	.047	.011	.093	.036	.031	–
V %	.016	.027	.018	.033	.021	.030	.036	.043	–
Sc %	.0044	.0069	.0010	.0040	.0020	.0035	.0033	.0037	–
Sr %	.020	.015	.29	.014	.043	.010	.019	.0082	–
Ba %	.0044	.014	.0095	.0045	.020	.0067	.0042	.0041	–
B ppm	350	nf	150	nf	nf	nf	nf	tr	–
Zn ppm	38	110	37	41	48	87	75	160	–
Pb ppm	tr	tr	17	4	1	tr	tr	3.4	–
Ag ppm	.24	.069	.066	.14	tr	.093	tr	tr	–
Zr %	nf	.020	.031	–	.016	.012	.015	.0079	–
Li ppm	–	–	–	–	–	–	–	–	–
Rb ppm	nf	.0053	nf	tr	tr	tr	–	tr	–

13-9; 73-47-69; 2-182A; 578590, 7414400; Metagabbro with medium grained relict plagioclase and quartz plagioclase mosaic, hornblende, sphene and epidote.

13-10; 73-47-74; 2-184A; 578500, 7414600; Gneissic metagabbro with relict plagioclase and quartz plagioclase mosaic, hornblende and biotite and actinolite and irregular opaques rimmed by sphene.

13-11; 73-47-91; 2-193A; 558600, 7407150; Epidote amphibolite with relict plagioclase and altered alkali feldspar quartz mosaic set in biotite hornblende, epidote and opaque matrix.

13-12; 73-47-108; 2-209B; 553500, 7399550; Coarse grained metagrabbro with relict plagioclase, quartz mosaic, porphyroblastic hornblende and chlorite as well as opaques and accessory allanite.

13-13; 73-47-65; 2-210B; 553790, 740070; Metagabbro with fine grained quartz plagioclase mosaic, hornblende and biotite, irregular opaques rimmed by sphene and accessory apatite and zircon.

13-14; 73-47-81; 2-210C, 553790, 7400070; Metagabbro with fine grained quartz plagioclase mosaic, hornblende, and biotite, irregular opaques rimmed by sphene and accessory apatite and zircon.

13-15; 73-47-92; 2-210C; 553790, 7400070; Metagabbro with relict plagioclase, quartz plagioclase mosaic, hornblende and a variety of opaque minerals.

13-16; 73-47-115; 2-210E; 553790, 740070; Metagabbro with plagioclase, quartz mosaic, zoned hornblendes with biotite and sphene.

13-17; LeMaître, 1976; Average gabbro ± one standard deviation.

Table 14. Chemical analyses of meta-anorthositic rocks

	1	2	3
Major Elements %			
SiO_2	47.00	44.00	51.05 ± 3.55
TiO_2	1.48	1.79	.63 ± 2.83
Al_2O_3	27.30	25.00	26.57 ± 4.54
Fe_2O_3	.80	4.1	.99 ± .81
FeO	4.30	3.3	2.07 ± 1.99
MnO	.10	.08	.05
MgO	1.93	1.80	2.14 ± 2.04
CaO	14.1	17.7	12.76 ± 3.35
Na_2O	1.9	1.0	3.14 ± 1.51
K_2O	.11	.10	.62 ± .60
P_2O_5	.08	.12	.09
H_2O	1.2	1.4	1.31
CO_2	.1	.0	.14
S	.03	.05	
Minor Elements			
Co %	.0016	.0020	
Ni %	.0047	.0060	
Cu %	.0081	.012	
Cr %	.0008	.0009	
V %	.018	.045	
Sc %	.0010	.0010	
Rb ppm	5	3	
Sr %	.023	.021	
Ba %	.0044	.0056	
Zr %	.0063	.0043	
Zn ppm	29	.	
Pb ppm	6	.	
Li ppm	9	8	

14-1[(1)]; 72-76-001[(2)]; 3-440D1[(3)], 7348780[(5)]; Anorthosite. Euhedral porphyritic feldspars (degraded in part to epidotes) with rare interstitial actinolite and chlorite SG = 2.78.

14-2; 72-76-002; 3-440D2; 475840, 7348780; Gabbroic anorthosite with euhedral feldspars (degraded to epidotes) with interstitial actinolite and chlorite. SG = 2.78.

14-3; Average anorthosite N = 104, LeMaître (1976)

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 15. Chemical analyses of rocks of the Kuagnat Gneiss Complex

	1	2	3	4	5	6	7	8	9
Major Elements %									
SiO_2	66.33	64.61	65.30	62.58	64.13	63.70	64.70	62.30	65.74
TiO_2	.53	.59	.49	.82	.73	.68	.64	.72	.56
Al_2O_3	15.14	15.17	15.90	14.77	14.57	15.23	15.06	15.08	14.59
Fe_2O_3	1.15	1.40	1.11	1.90	1.85	1.62	1.21	1.52	1.01
FeO	3.20	3.50	2.90	4.10	3.40	3.50	3.90	4.40	3.50
MnO	.09	.11	.08	.11	.11	.10	.10	.13	.10
MgO	2.35	2.67	2.29	3.43	3.22	2.93	2.51	3.09	2.27
CaO	4.55	4.71	4.25	5.56	5.16	5.11	5.01	5.41	4.90
Na_2O	4.55	4.36	4.77	3.73	3.82	4.13	4.37	4.32	4.44
K_2O	1.54	1.66	1.73	1.73	1.64	1.72	1.79	1.86	1.67
P_2O_5	.20	.20	.19	.28	.25	.25	.24	.26	.21
CO_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H_2O	.80	1.00	1.00	1.30	1.10	1.20	.60	1.10	.80
S	0.00	.00	.01	.00	.00	.01	0.00	0.00	.01
Minor Elements									
Co %	tr	.0015	tr	.0016	.0016	.0013	.0011	.0014	tr
Ni %	.0026	.0031	.0019	.0045	.0038	.0032	.0032	.0040	.0026
Cu %	.0014	.0022	.0029	.0033	.0032	.0061	.0007	.0005	.0005
Cr %	.0026	.0028	.0023	.0034	.0032	.0029	.0030	.0031	.0028
V %	.013	.014	.012	.018	.017	.015	.015	.016	.013
Sc %	.0011	.0011	.0010	.0014	.0013	.0011	.0011	.0014	.0012
Rb %	79	86	89	73	69	72	59	63	51
Sr %	.034	.032	.035	.035	.037	.039	.035	.032	.034
Ba %	.030	.026	.026	.052	.049	.050	.048	.047	.051
Zr %	.016	.039	.014	.021	.019	.017	.028	.034	.015
B ppm	tr	tr	tr	tr	tr	tr	nf	nf	nf
Zn ppm	66	91	63	90	82	77	80	92	86
Pb ppm	8	10	12	4	5	4	1	4	4
Ag ppm	tr	tr	tr	tr	tr	tr	tr	.1	tr
Li ppm	41	22	22	27	26	29	58	55	42
F %	.05	.05	.04	.06	.05	.06	.05	.06	.05
Cl %	.03	.01	.01	.02	.00	.01	.04	.02	.00
Sn ppm	2	3	2	2	2	2	2	2	1
Y ppm	tr	tr	tr	tr	tr	tr	tr	tr	tr

15-1[(1)]; 74-21-176[(2)]; 3-4012[(3)]; 530280[(4)], 7430270[(5)]; Degraded plagioclase-phyric biotite gneiss with quartz, altered plagioclase with white mica, hornblende with chlorite, biotite altered to chlorite and epidote, opaques and sphene, as well as dotted by opaques, epidote, allanite and hematite (SG = 2.68).

15-2; 74-21-177; 3-4013; 530280, 4730270; Degraded plagioclase-phyric biotite gneiss with quartz, altered plagioclase with white mica, hornblende with chlorite, biotite, opaques and sphene, as well as dotted by carbonate epidotes, allanite and hematite.

15-3; 74-21-178; 3-4014; 530280, 7430270; Degraded plagioclase-phyric biotite gneiss with quartz, altered feldspar, hornblende with chlorite, biotite altered to chlorite and epidote, opaques and sphene, as well as dotted by epidote, pumpelleyite(?) and hematite.

15-4; 74-21-179; 3-4015; 534420, 7426200; Degraded biotite gneiss with altered plagioclase porphyroblasts set in quartzofeldspathic matrix and hornblende with chlorite, biotite altered to epidote-chlorite, and sphene and opaque matrix dotted and veined by epidote, allanite and apatite (SG = 2.74).

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

15-5; 74-21-180; 3-4016; 534420, 7426200; Degraded biotite gneiss with altered plagioclase porphyroblasts set in quartzofeldspathic matrix, and hornblende with chlorite, biotite and sphene and opaques dotted by epidote, allanite, zircon and apatite.

15-6; 74-21-181; 3-4017; 534420, 7426200; Degraded biotite gneiss with altered plagioclase porphyroblasts set in quartzofeldspathic matrix and biotite, hornblende with chlorite, sphene and opaques and epidote with accessory allanite, zircon, apatite and hematite.

15-7; 74-21-182; 3-4018; 537260, 7422280; Degraded biotite gneiss with strained plagioclase porphyroblasts set in strained quartz and graphic granite matrix with strained hornblende with chlorite, fresh biotite, sphene and epidote with accessory zircon, apatite, allanite and hematite (SG = 2.75).

15-8; 74-21-183; 3-4019; 537260, 7422280; Degraded biotite gneiss with strained altered poikiloblastic plagioclase porphyroblasts set in quartz and graphic granite matrix with hornblende, chlorite, biotite, sphene, opaques, epidote and carbonate with accessory zircon and apatite.

15-9; 74-21-184; 3-4020; 537260, 7422280; Degraded biotite gneiss with strained poikiloblastic plagioclase and quartz grains set in a matrix of fine grained quartz, plagioclase, and graphic granite with biotite, hornblende, opaques, sphene, epidote and carbonate with accessory allanite and apatite.

Table 16. Chemical analyses of granitic gneisses from the Walker Lake Gneiss Complex

	1	2	3	4	5	6	7	8	9	10	11	12	13
Major Elements %													
SiO_2	68.07	71.37	67.20	69.04	70.14	70.13	64.85	64.02	64.32	65.12	64.29	66.37	66.9
TiO_2	.32	.26	.42	.32	.31	.30	.39	.45	.42	.74	.69	.78	.55
Al_2O_3	16.51	15.13	16.20	15.36	15.69	15.16	16.47	16.13	16.46	15.15	15.40	15.42	15.5
Fe_2O_3	.06	.10	.23	.59	.47	.47	1.44	0.00	1.21	1.58	1.41	1.36	.9
FeO	2.30	1.80	2.80	1.40	1.50	1.40	2.70	6.00	2.90	3.10	2.90	2.40	3.3
MnO	.05	.03	.06	.04	.04	.04	.08	.09	.08	0.12	.11	.11	.07
MgO	1.32	1.04	1.79	1.09	1.11	1.00	2.33	2.62	2.26	1.85	1.76	1.61	1.5
CaO	3.89	2.78	3.77	2.21	2.06	2.16	5.07	4.94	5.25	3.43	3.24	3.49	2.9
Na_2O	4.46	3.52	4.21	5.36	5.16	5.11	4.15	3.95	4.13	3.68	3.78	4.10	3.7
K_2O	2.29	3.67	2.32	3.13	3.24	3.23	1.91	1.89	1.52	4.02	4.12	3.65	3.7
P_2O_5	.17	.13	.20	.16	.16	.15	.15	.15	.15	.42	.34	.31	.20
CO_2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.03	.00	.0
H_2O	.90	.40	.50	.80	.50	.70	.70	1.20	1.20	.70	1.80	.80	.8
S	.08	.06	.07	.01	.01	.01	.01	.00	.01	.04	.02	.04	-
Minor Elements													
Co %	tr	tr	tr	tr	tr	tr	tr	tr	tr	.0013	tr	tr	
Ni %	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	
Cu %	.0015	.0013	.0015	.0013	.0013	.0013				.0011	.0007	.0010	
Cr %	.0012	tr	.0012	.0014	.0011	.0012	.0016	.0017	.0020	.0016	tr	tr	
V %	.0047	.0035	.0071	.0043	.0042	.0036	.011	.011	.011	.011	.0078	.0070	
Sc %	.0059	tr	tr	.0005	tr	tr	.0010	.0010	.0011	.0014	.0009	.0013	
Rb %	90	97	103	97	102	107	62	49	61	165	171	144	
Sr %	.054	.049	.054	.065	.065	.057	.037	.040	.043	.051	.054	.052	
Ba %	.060	.092	.033				.075	.046	.075	.075	.097	.093	
Zr %	.018	.0044	.017	.016	.017	.013	.014	.029	.017	.078	.038	.031	
B ppm	nf	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	
Zn ppm	57	33	48	32	27	30	55	44	58	58	69	68	
Pb ppm	.15	20	12	11	8	16	15	12	12	20	20	26	
Ag ppm	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	tr	
Li ppm	77	59	112	29	30	32	25	21	30	45	32	56	
F %	.05	.04	.06	.04	.04	.06	.03	.03	.03	.14	.14	.13	
Cl %	.00	.01	.02	.01	.00	.01	.01	.01	.02	.04	.01	.01	
Sn ppm	3	2	4	tr	tr	1	1	1	2	4	3	4	
Y ppm	tr	tr	tr	tr	tr	tr	tr	tr	tr	.0046	.0023	.0040	
La ppm	tr	tr	tr	.0053	tr	tr	tr	tr	tr	.015	.0092	.011	

16-1[1]; 74-21-185[2]; 3-4021[3]; 541630[4], 7419750[5]; Reddish weathering granitic gneiss with strained feldspar with white mica and strained quartz grains with interstitial graphic granite and variably chloritized biotite, sphene, opaques and epidote with accessory zircon and apatite (SG = 2.61).

16-2; 74-21-186; 3-4022; 541630, 7419750; Granitic gneiss wih quartz, relict feldspars, graphic granite and variably chloritized biotite, sphene, opaques and epidote with accessory zircon and apatite.

16-3; 74-21-187; 3-4023; 541630, 7419750; Granitic gneiss with quartz, relict plagioclase with muscovite, microcline and biotite with opaques, sphene and epidote, and accessory allanite, zircon and appatite.

16-4; 74-21-207; 3-4043; 558720, 7391790; Granitic gneiss with quartz, relict and recrystallized plagioclase, microcline, graphic granite with chloritized biotite and dotted with white mica, opaques, chlorite and epidote, with accessory zircon, allanite and apatite (SG = 2.62).

16-5; 74-21-208; 3-4044; 558720, 7391790; Granitic gneiss with quartz, relict and recrystallized plagioclase, microcline, graphic granite with chloritized biotite and dotted with white mica, sphene, opaques, chlorite and epidote with accessory allanite, zircon and apatite.

16-6; 74-21-209; 3-4045; 558720, 7391790; Granitic gneiss with quartz, relict and recrystallized plagioclase, microcline with biotite and dotted with chlorite(?), white mica, sphene, opaques, epidote and carbonate with accessory allanite, zircon and apatite.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

16-7; 74-21-210; 3-4046; 562980, 7390500; Granitic gneiss with augened poikiloblastic and strained plagioclase and quartz set in biotite-rich epidotized quartzofeldspathic matrix. Biotite is altered to epidote, fluorite and chlorite with accessory apatite and zircon (SG = 2.60).

16-8; 74-21-211; 3-4047; 562980, 7390500; Granitic gneiss with thin shear zones. Quartz locally polygonized, altered poikiloblastic relict feldspar, chloritized biotite and rare hornblende, irregular opaques are dotted with epidote; and hematite.

16-9; 74-21-212; 3-4048; 562980, 7390500; Sheared granitic gneiss with quartz, altered plagioclase, chloritized biotite, rare hornblende, irregular opaques are dotted with epidote and hematite and accessory zircon, allanite and apatite.

16-10; 74-21-213; 3-4049; 566660, 7384950; Granitic gneiss with quartz, plagioclase, microcline, and interstitial graphic granite with rare hornblende and chloritized biotite dotted with epidote, opaques, sphene, carbonate, fluorite, and accessory apatite and allanite (SG = 2.56).

16-11; 74-21-214; 3-4050; 566660, 7384950; Granitic gneiss with quartz, plagioclase and microcline with interstitial graphic granite with rare hornblende and bent chloritized biotite with lamellae of epidote and fluorite dotted with opaques, sphene, chlorite and accessory zircon, allanite, rutile and apatite.

16-12; 74-21-215; 3-4051; 566660, 7384950; Granitic gneiss with quartz, plagioclase, microcline and graphic granite with rare hornblende, chloritized biotite dotted with opaques, sphene, carbonate, fluorite and accessory zircon, apatite, allanite and rutile.

16-13; Average gneiss northern Keewatin district, Eade and Fahrig, 1971, p. 49.

Table 17. Chemical analyses of some granitic plutons

	1	2	3	4
Major Elements %				
SiO_2	73.70	72.0 ± 4.3	67.50	66.8 ± 4.4
TiO_2	.01	.3 ± .3	.28	.54 ± .3
Al_2O_3	15.10	14.4 ± 2.0	16.60	16.0 ± 1.5
Fe_2O_3	.0	1.2 ± 1.2	.90	1.5 ± 1.1
FeO	.50	1.7 ± 1.4	.60	2.9 ± 1.5
MgO	.34	.7 ± .7	1.34	1.8 ± 1.1
MnO	.01		.02	
CaO	.31	1.8 ± 1.4	1.42	3.9 ± 1.5
Na_2O	4.60	3.7 ± 1.1	6.00	3.8 ± .9
K_2O	4.86	4.1 ± 1.4	3.68	2.8 ± 1.0
P_2O_5	.09		.10	
CO_2	.00		.00	
H_2O	.40		.60	
S	.00		.06	
Minor Elements				
Rb ppm	184		73	
Sr %	0038		0530	
Zr %	0029		0270	
Pb ppm	32		8	
Ba %	0065		1200	
Li ppm	32		18	
Cs ppm	7		10	
V %	0020		0042	
Zn ppm	tr		21	

17-1[(1)]; 72-75-028[(2)]; 3-5121[(3)]; 546820[(4)], 7410180[(5)]; white weathering muscovite granite with small amount of accessory biotite altered to chlorite (SG = 2.61).

17-2[(1)]; LeMaître's (1976) average granite; N = 2236.

17-3[(1)]; 72-76-029[(2)]; 3-5128[(3)]; 548580[(4)]; 7410880[(5)]; Pink weathering biotite granite in which mafics are now biotite, epidote, chlorite, lamellated. Muscovite and porphyroblastic poikilitic feldspar is present (SG = 2.62).

17-3[(1)]; LeMaître's (1976) average granodiorite; N = 723.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 18. Chemical analyses of "probably mid-Aphebian" metadiabase dykes

%	1	2	3
SiO_2	49.2 ± 2.0	48.20	51.6 ± 3.83
TiO_2	1.7 ± .3	1.40	1.5 ± 1.1
Al_2O_3	13.99 ± .76	14.50	15.3 ± 2.6
Fe_2O_3	1.97 ± 2.8	3.00	3.49 ± 2.4
FeO	11.70 ± .76	10.40	8.52 ± 2.6
MnO	.21 ± .01	.20	
MgO	5.90 ± 1.49	6.80	6.43 ± 2.89
CaO	9.60 ± .72	10.80	9.04 ± 2.31
Na_2O	2.64 ± .57	2.20	3.01 ± 1.20
K_2O	.83 ± .19	.39	1.04 ± .71
P_2O_5	.26 ± .05	.26	
CO_2	.00 ± .00	.00	
H_2O	1.64 ± .36	1.50	
S	.04 ± .05	.01	
Range of 9			
Zn ppm	80 - 110		
Pb ppm	<.5 - 1.7		
Sn ppm	.72 - 2.7		
B ppm	<10		
Ag ppm	<.050		
Li ppm	13 - 20		
Sr %	.024 - .038		
Rb ppm	14 - 31		
Ba %	.022 - .034		
Cr %	.0073 - .015		
Zr %	.017 - .023		
V %	.030 - .044		
Ni %	.0035 - .0084		
Y %	.0020 - .0032		
Co %	.0039 - .0052		
Sc %	.0026 - .0035		
Cl %	.01 - .03		
F %	.02 - .04		

*Range of nine analyses

18-1[(1)]; 74-21-(164-172)[(2)] inclusive and 74-21-(204-206)[(2)]; 3-(4000-4008)[(3)] and 3-(4040-4042)[(3)]; 550500[(4)], 7402400[(5)] and 555000[(4)], 7397500[(5)]; Average value of 12 core samples taken in a single metagabbroic dyke. In thin section it is seen to consist of relict plagioclase with recrystallized quartzo-feldspathic matrix containing small actinolite needless intergrown with hornblende locally chloritized or uralitized and rare chloritized biotite, as well as opaques, leucoxene, accessory apatite, zircon and veined by clinozoisite.

18-2; 73-47-109; 2-0158; 572090, 7407490; Metagabbro, relict plagioclase and recrystallized fine grain mosaic of quartz and plagioclase as well as poikiloblastic hornblendes and fine grained opaques.

18-3; Average Diabase (LeMaître, 1976).

(1) Table and specimen number
(2) Laboratory numbers
(3) Field numbers
(4) UTME
(5) UTMN (all UTM's in zone 15W)

Table 19. Chemical analyses of a rock from a late granitic pluton

	Major Elements		Minor Elements
	19-1	19-2	19-1
SiO_2	74.20	72.0 ± 4.3	Rb 138 ppm
TiO_2	.22	.3 ± .3	Sr .0079 %
Al_2O_3	14.20	14.4 ± 2.0	Ba .083 %
Fe_2O_3	.80	1.2 ± 1.2	Zr .014 %
FeO	.30	1.7 ± 1.4	Pb 22 ppm
MnO	.02		Zn 48 ppm
MgO	.33	.7 ± .7	Cu .0005 %
CaO	.46	1.8 ± 1.4	Cr .0012 %
Na_2O	3.00	3.7 ± 1.0	Li 8 ppm
K_2O	6.30	4.1 ± 1.4	
P_2O_5	.04		
CO_2	.00		
H_2O	.40		
S	.00		

19-1[(1)]; 72-76-003[(2)]; 3-0421[(3)]; 555300[(4)], 7401150[(5)]; Red granite containing elongated quartz grains set in slightly degraded quartz and alkali feldspar with rare chlorite and blue-green amphibole, and spotted with sporadic carbonate, tourmaline, and pyrite. (SG = 2.56)

19-2; LeMaître's (1976) average granite; N = 2236.

(1) Table and specimen number
(2) Laboratory number
(3) Field number
(4) UTME
(5) UTMN (all UTM's in zone 15W)

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